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Black-Footed Ferret Habitat:

Some Management and Reintroduction Considerations

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Wildlife Technical Bulletin No. 2

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Frontispiece: Three black-footed ferrets. Photo by Tim W. Clark.

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BLACK-FOOTED FERRET HABITAT: SOME MANAGEMENT AND REINTRODUCTION CONSIDERATIONS

Wyoming BLM Wildlife Technical Bulletin No. 2

August 1985

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PREFACE

The endangered black-footed ferret *(Mustela nigripes)* once inhabited extensive areas of the western plains. Today, only one population near Meeteetse, Wyoming, is known, even though substantial areas of its principal prey and associate, prairie dogs *(Cynomys spp.)*, are still found throughout its historic range. Human land use during the last century has greatly altered prairie dog distribution and abundance. Most people now agree that these drastic changes led to the decline of ferrets.

Any strategy for proactive management of the Meeteetse black-footed ferrets (BFFs) or for the full recovery of the species requires an understanding of ferret habitat. BFF captive breeding and reintroduction is currently under discussion. The need for a set of objective and easily applied criteria for selecting reintroduction sites are needed. Identifying suitable habitat may now be the most critical bottleneck facing recovery of the species. This document represents a first order understanding of ferret habitat and, we hope, a further step in developing that critical bank of data, management tools, and personal interests needed to recover this unique species.

ACKNOWLEDGMENTS

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We are deeply indebted to Meeteetse area ranchers who maintain ferret habitat and to citizens of the Meeteetse area who provide friendship and support. We are grateful to those who assisted in field data collection over many long and often difficult hours. The following people donated their time: Denise Casey, Jeremy Petts, John Duwaldt, Lorrie Lee, Mike Karl, Jim Hasbrouck, David Skryja, Brent Houston, Tory and Meredith Taylor, Jock Coyningham, Helen Ballew, Scott Findhold, Craig Groves, Ted Nusbaum, Renee Askins, and Jeff Grenier. We also thank our colleagues in the Denver Wildlife Research Center, U.S. Fish and Wildlife Service—Dean Biggins, Kathy Fagerstone, and Lou Hanebury—for their support, friendship, enthusiasm, and ideas.

This document was critically reviewed by Wayne Brewster and Ron Crete, Office of Endangered Species, USFWS; John Cada and Dennis Flath, Montana Game, Fish and Parks; Craig Groves, Idaho Heritage Program; Harry Harju and Brian Miller, Wyoming Game and Fish; John Hubbard, New Mexico Game and Fish; Don Streubel, Biological Sciences, Idaho State University; and Mark Stromberg, National Audubon Society.

Edson Fichter, Pocatello, Idaho, graciously donated the black-footed ferret montage for the cover. Denise Casey, Biota Research and Consulting, provided technical and editorial review and drew figures for the text. The American Society of Mammalogy kindly gave permission to reprint available Mammalian Species accounts for prairie dogs. Thanks also to Joe Collins, Ronald Turner, and the University of Kansas Press for allowing us to reprint the black-tailed prairie dog "species account." Finally, this document would not have been published without the support of Jim Roseberry and the Wyoming Bureau of Land Management, Cheyenne.

INTRODUCTION

Few attempts have been made to define black-footed ferret (BFF) habitat criteria, largely because so little was previously known of the species. Hillman et al. (1979) made suggestions about minimum prairie dog areas needed to support BFFs based on studies of a small population in South Dakota during the 1960's and early '70's, and Stromberg et al. (1983) developed habitat estimates based on theoretical bioenergetic models of ferret energy requirements and average prey densities from the literature.

This paper describes: (1) some habitat features associated with the single known BFF population near Meeteetse, Wyoming, (2) ferret use of this habitat from 1981-1984, and (3) recommendations for choosing potential BFF reintroduction sites based on these data with some easily applied criteria for assessing such sites.

BLACK-FOOTED FERRET HABITAT

Historical Habitat

The relationship between BFFs and prairie dogs has long been known (Coues 1877, Bailey 1905, Warren 1910). BFFs live in the burrows made by prairie dogs and probably exploit these rodents as their major food resource (Sheets et al. 1972). In fact, the high biomass of potential prey species (Clark et al. 1982) and the abundance of burrows are probably equally important factors in attracting BFFs to this habitat.

BFF specimens have been collected from over 120 of some 500 counties within the historic range of *Cynomys* in the U.S. (Arizona, Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming) and two Canadian provinces (Alberta and Saskatchewan; Fig. 1). Ethnographic accounts indicate that plains Indian tribes throughout this range were familiar with BFFs (Bailey 1926, Henderson et al. 1969, Clark 1975). Forty-two ferrets were taken in South Dakota between 1923-28 alone (Linder et al. 1972). Based on this and other evidence it has been argued that BFFs were probably less rare than previously thought (Linder et al. 1972, Hubbard and Schmitt 1984).

Of nearly 300 ferret specimens presently in museums, less than a half dozen were collected away from prairie dog colonies. In those cases reports are of single individuals, such as one ferret found drowned in a lake above 3000 m (Warren 1910) or one killed in a haystack (Henderson et al. 1969). BFFs with young were observed only on prairie dog colonies during nine years of the South Dakota study (Henderson et al. 1969, Hillman and Linder 1973) and have been found only on prairie dog colonies at Meeteetse to date. BFF remains continue to be found on prairie dog colonies in locations where no previous record of BFF occupancy existed, extending the species' known range (Bissel 1979, Martin and Schroeder 1979, 1980, Boggess et al. 1980, Clark and Campbell 1981).

Nelson (1919) estimated that over 100 million acres (40.5 million ha) of western rangelands were occupied by prairie dogs in the early 1900's. Accounts of huge prairie dog towns are common (Texas Panhandle-250 mi (400 km) long, Bailey 1905; Cheyenne River, Wyoming-100 mi (160 km) long, Day and Nelson 1929; Montana-100 mi (160 km) long, D. Flath Pers. comm.). Many areas show evidence of extensive former occupancy by prairie dogs, e.g., southern Albany and Laramie Co.'s, Wyoming, where mounds can still be seen. Until about five decades ago, prairie dog colonies probably provided a nearly contiguous matrix of high-quality ferret habitat, interrupted by areas of undisturbed range and shrubland or major physiographic barriers (mountain ranges and large rivers). In some states reductions as large as 90% of the area formerly occupied by prairie dogs have occurred (Rose 1973, Tyler 1968).

Various land use practices, particularly cultivation and poisoning campaigns (U.S. Bureau of Land Management 1982), have resulted in restricted and isolated distributions of prairie dogs in most areas and total elimination in others.

Current Habitat

Three species of prairie dogs are known to support BFFs: black-tailed prairie dogs *(C. ludovicianus)* on the shortgrass prairies of the Great Plains and Southwest; white-tailed prairie dogs *(C. leucurus)* in the intermontane basins of the central Rockies; and Gunnison's prairie dogs *(C. gunnisoni)* in the mountain basins of the Southwest (Hall 1981; Appendix I).

Prairie dogs live in colonial groups composed of individuals which are in sight and sound of at least one other individual for predator defense and other social behavior (Hoogland 1981, Clark et al. 1985). Colony boundaries (where burrow openings stop) can generally be seen and mapped from aerial or ground surveys. Black-tailed prairie dogs are highly colonial and their colonies have distinct boundaries which rarely pose a problem in mapping.

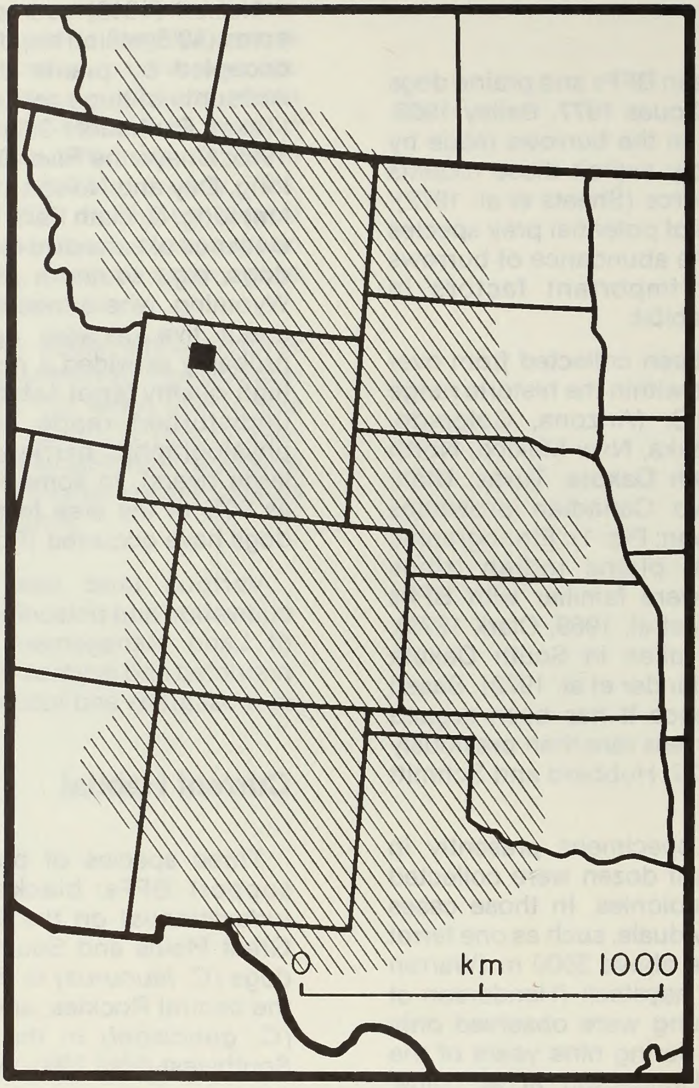

Figure 1. Former range of the black-footed ferret showing location of the Meeteetse, Wyoming, (square) study area (Hillman and Clark 1980).

White-tailed prairie dogs, however, often occur at much lower densities, particularly around the periphery of more densely occupied areas, which makes the colony boundaries indistinct and thus more difficult to map. For understanding BFF/prairie dog relations, managers and researchers must consistently agree in mapping colony boundaries. Therefore, we suggest that **areas with 10+** burrow openings/ha be defined as colonies, and that **areas of lesser density be defined as "scattered" and disregarded in mapping.**

Prairie dog colonies are not presently distributed uniformly over the landscape, but occur in clusters or clumps (Hillman et al. 1979, Pizzimenti 1981). Some have used site factors such as soils, climate, and vegetation to explain this clustering (e.g., Stromberg 1975, Collier 1975). However, human land use during the past century has probably been equally significant in creating this clumped distribution by confining surviving prairie dogs to poor or abused ranges or areas too remote or difficult to develop. The intensity and extent of past and continuing control efforts also influence the vigor and size of colonies and clumps as we see them today. Areas which may have been historically patchy have also been diminished in size and therefore have become increasingly isolated from each other.

We can never expect prairie dog populations to occupy the extensive ranges that have been historically described. Prairie dog eradication from various sources will continue with varying intensity. This drives other wildlife species which commonly inhabit prairie dog colonies to seek refuge in remaining "islands" of natural habitat, many of which have no habitat bridges to other "islands." For BFFs, these habitat islands may not be large or close enough to exchange genetic stock or additional numbers, and individuals which migrate from these islands may not be able to find or reach adequate new habitat. Thus, the size and distribution of these habitat islands appears critical for the continued existence of BFFs. **We define a group of prairie dog colonies distributed so that individual BFFs (and thus genetic material) can migrate among them commonly and frequently as a "prairie dog colony complex."** We will operationally define the size and distribution of colonies and complexes necessary to support viable BFF populations in the following discussion. The prairie dog colony complex therefore represents the basic management unit for a population of BFFs.

In summary:

(1) *Cynomys* spp. are the principal associates of the BFF. Breeding populations of BFFs have been recorded only on prairie dog colonies despite several accounts of single individuals in other locations.

(2) BFFs were probably less rare historically than previously thought. BFF specimens have been collected from virtually all parts of the range of *Cynomys* (with the exception of *C. parvidens*, a geographically disjunct species), indicating that BFFs probably occupied nearly all adequate prairie dog habitat available to them regardless of prairie dog species, vegetation, soils, or climate.

(3) The present distribution of active prairie dog colonies and land use patterns suggest that, realistically, the BFF will be confined to isolated habitat refugia. Prairie dog colonies which are grouped so that BFFs could utilize them as virtually contiguous habitat are called prairie dog colony complexes.

MEETEETSE BLACK-FOOTED FERRET HABITAT

Study Area

Prairie dogs at Meeteetse are found primarily on and between alluvial outwash benches of the Carter and Absaroka Mountain foothills from 1980 m to 2290 m where slopes do not exceed 30% (Fig. 2). Two major vegetative types, mixed shrub *(Artemisia tridentata/Koeleria cristata)* and junegrass *(K. cristata)*, dominate in the prairie dog colonies (Fig. 3). This vegetation is typically the result of historically heavy livestock use (Collins and Lichvar 1984).

Average annual precipitation is 30 cm (Collins and Lichvar 1984). Average seasonal snowfall is 81 cm. Snow cover does not persist on the study area throughout the winter, but typically melts or blows off between storms. Temperature extremes of 32° in the summer to -44°C in the winter have been recorded. Mean monthly temperatures range from -6° to 7°C. Winds average 13-16 km/hr.

Soils are: shallow (0.5m) and underlain by unconsolidated gravels; well drained, medium-textured clay-loams (ca. 1 m in depth); or clays derived from shale parent materials.

Methods

Field studies described here were conducted from October 1981 to October 1984. Methods for locating BFFs are discussed in Clark et al. (1984), Richardson et al. (1985), Richardson et al. (in prep), and Campbell et al. (1985).

Prairie dog colonies were initially mapped from aerial surveys and subsequently ground checked using criteria suggested in the preceding section. The results were mapped on 1:4800 maps we prepared and 1:2953 topographic maps supplied by the U.S. Forest Service, Region 2, through D.E. Biggins, U.S. Fish and Wildlife Service. Areas of prairie dog colonies were computed to the nearest 0.5 ha from the maps and from ground measurements.

Estimates of BFF activity areas were generated from our records of snow tracks and from radio-telemetry studies conducted jointly with the Denver Wildlife Research Center (DWRC), U.S. Fish and Wildlife Service, in 1982. Subsequent telemetry work was conducted independently by the Fish and Wildlife Service in 1983 and 1984 (Biggins and Fagerstone 1983, Biggins et al. 1985, D.E. Biggins, pers. comm.). We used maps of ferret tracks in snow to construct "minimum use area polygons" for individual BFFs (Richardson et al. in prep.) by joining the outermost boundaries of track records. Individuals could be identified by following an animal on consecutive days when good snow cover persisted (combined with visual checks of some animals) or by identifying unique geographic areas used. Telemetry methods are discussed in Biggins et al. (1985). Some movement data were collected from mark/recapture studies conducted jointly with DWRC from 1982-84 using methods described by Fagerstone et a1. (1985).

Burrow entrances were mapped and counted on all colonies shown in Figure 4 in 1982 and on colony #25-East Core in 1982, 1983, and 1984. East Core was divided into 52 plots ranging from 0.6 to 23.5 ha by drainages, ridges, roads, and colony boundaries. Average burrow density was computed for each plot. Mean burrow density in areas of ferret activity was computed by taking a weighted average of plots falling within the activity area.

Two seasonal BFF population counts were made:

(1) Summer counts were made during simultaneous (or near simultaneous) spotlight coverage of individual colonies on consecutive nights by up to five observers or teams (depending on colony size and ease of coverage) during July and early August of each year. Larger colonies (greater than 100 ha) were broken up into smaller, manageable survey units. At this time, we searched primarily for litters, but also identified individuals not associated with litters. We observed no migration by litters within or between colonies during these surveys, and we stipulated that litters or individuals be seen simultaneously or in sequence to individuate groups or individuals. The population estimate was therefore as conservative as possible. Lincoln-Peterson estimates based on mark/recapture data taken in 1984 were found to be almost identical to this summer count in 1984 (Forrest et al., 1985b).

(2) Winter counts were made from December through March each year, when snow cover was adequate. Counts made in March are called "spring" counts. Separate individuals could be identified from track records which occurred in disjunct geographic areas or from track records where the burrow from which the ferret originated to the burrow where the track terminated could be found. Consecutive tracking days were necessary to develop winter estimates since all ferrets were not active every night.

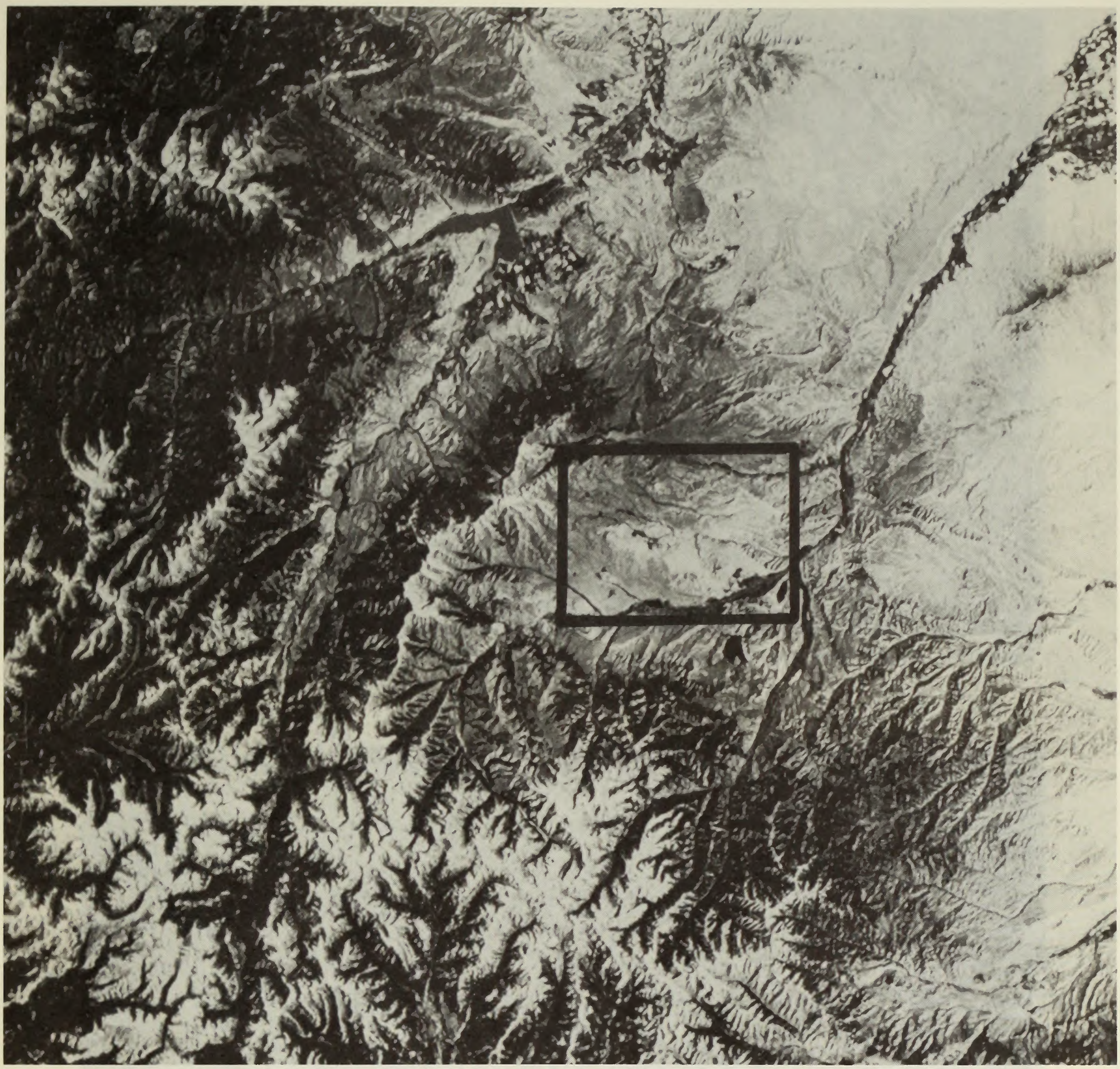

Figure 2. The upper Greybull River as seen from Landsat imagery (USGS EROS Data Center). The area described as BFF habitat is outlined.

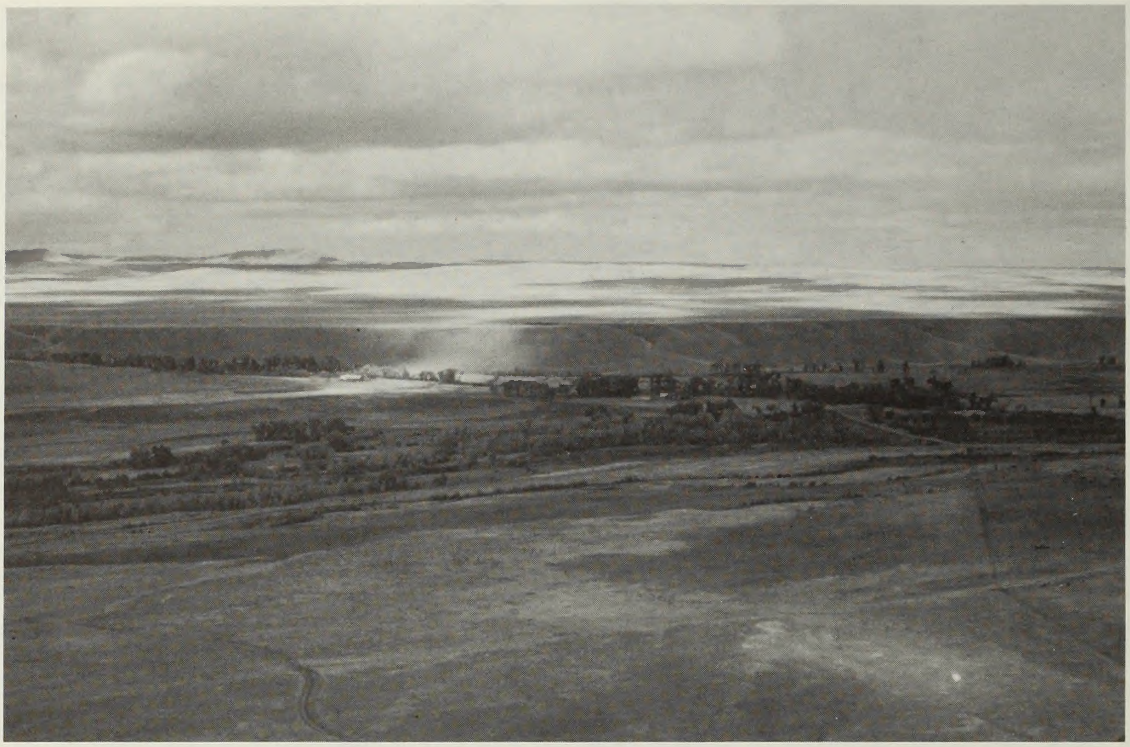

Figure 3-A. Upland benches of the upper Greybull River.

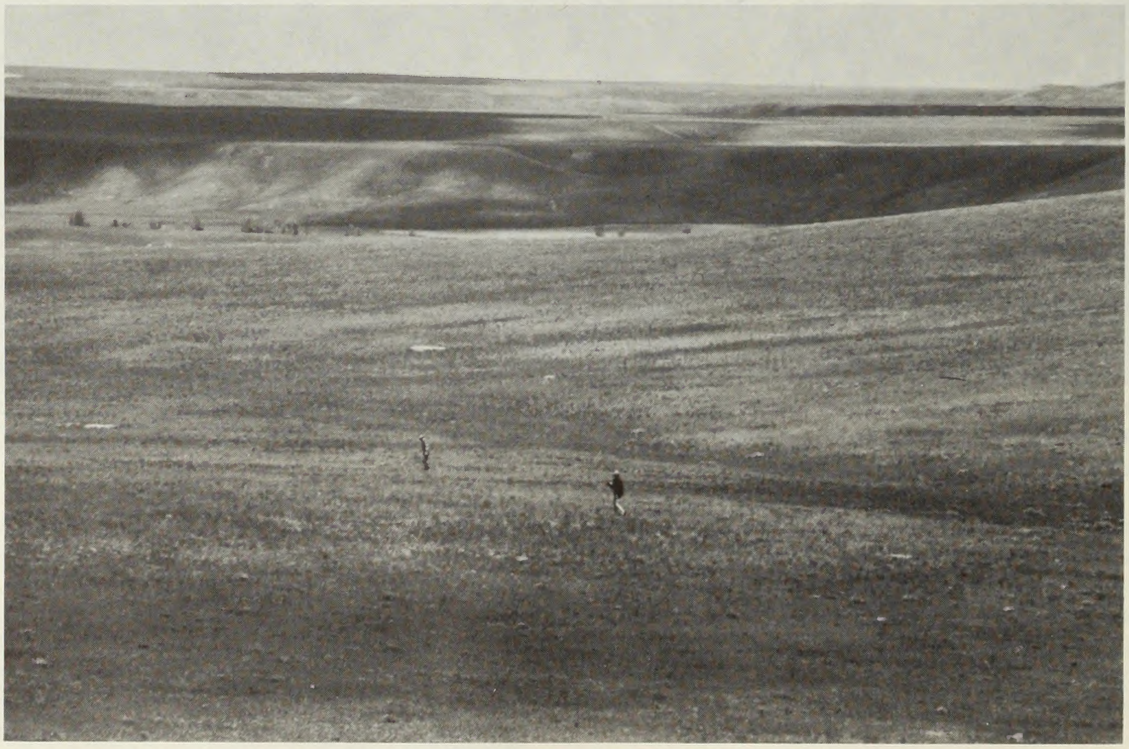

Figure 3-B. Prairie dog and BFF habitat at Meeteetse.

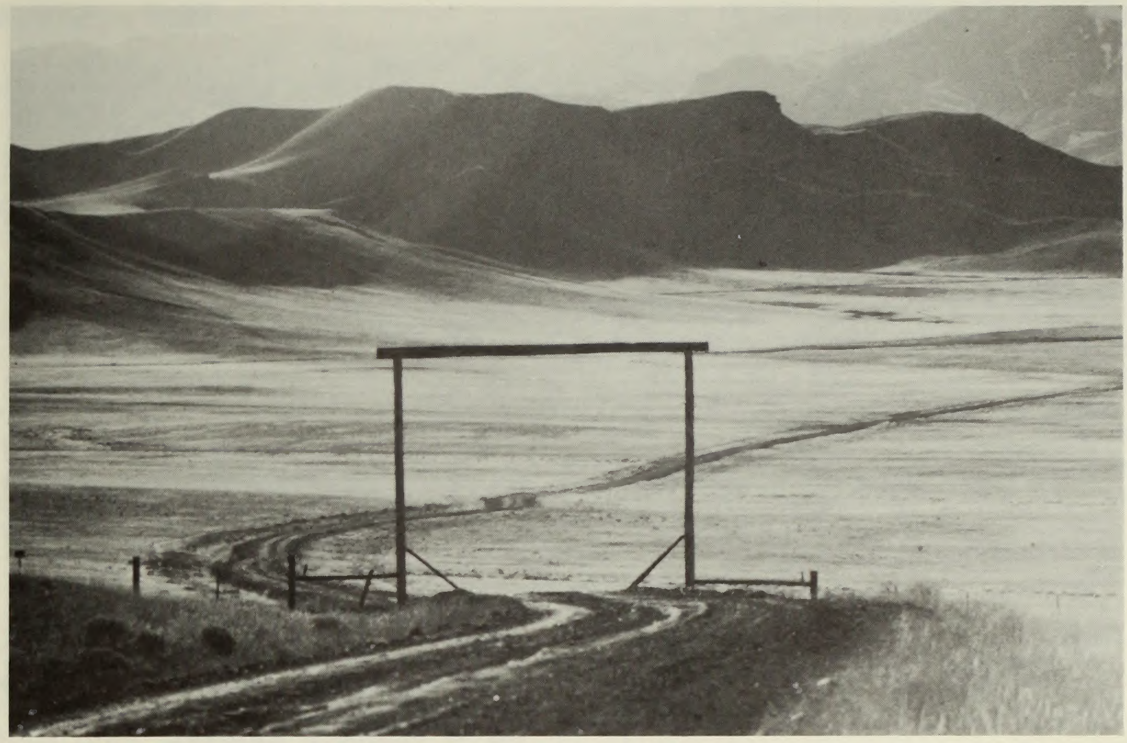

Figure 3-C. Prairie dog and BFF habitat at Meeteetse.

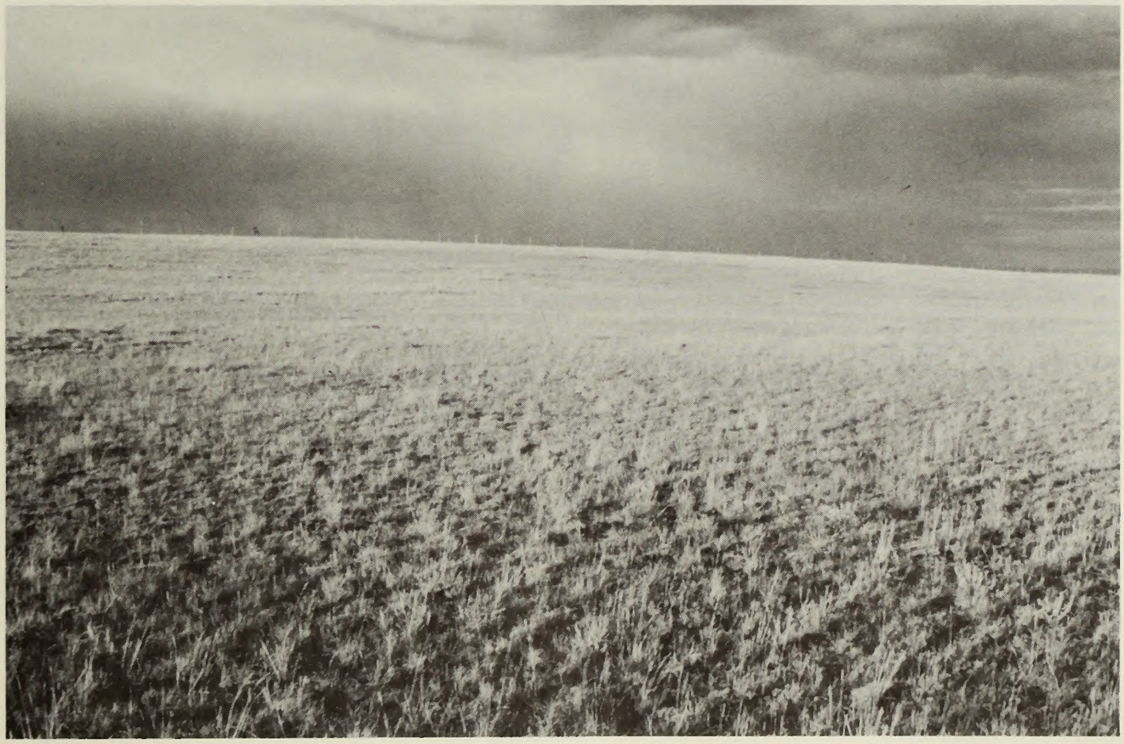

Figure 3-D. Junegrass dominated area.

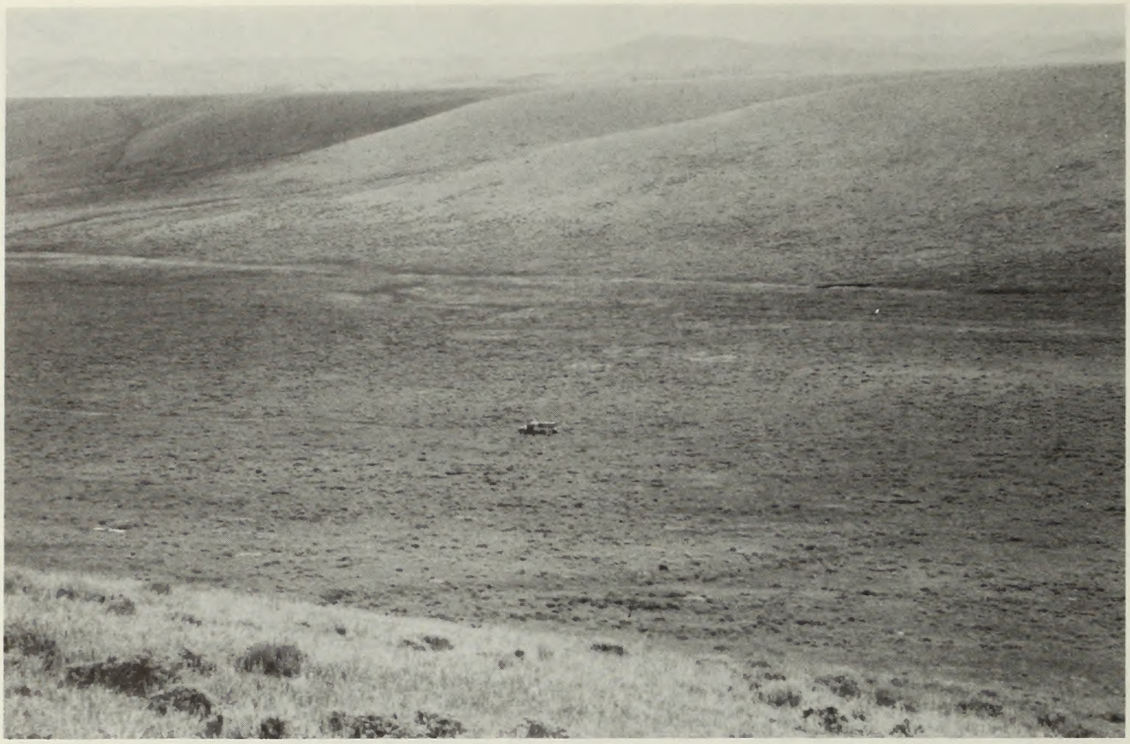

Figure 3-E. Sagebrush/junegrass type.

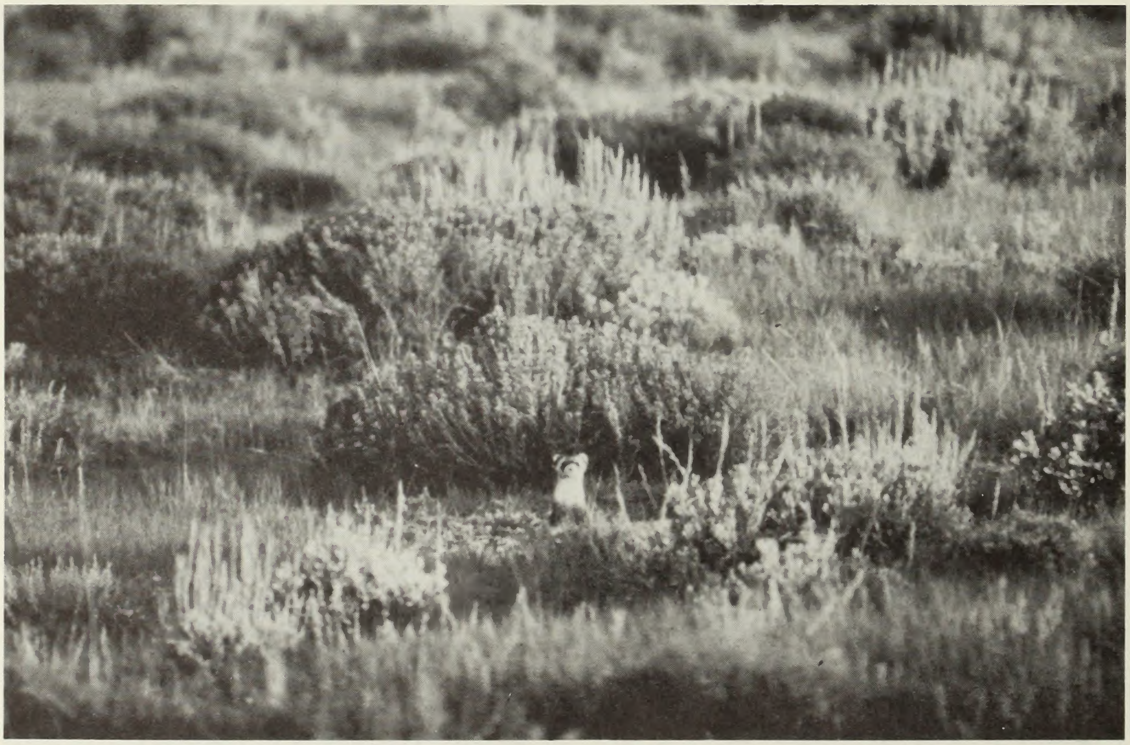

Figure 3-F. BFF and its environment.

The Meeteetse Habitat

Thirty-three prairie dog colonies ranging from 0.5 to 1302.0 ha are found in approximately 200 sq km west of Meeteetse (Fig. 4). Of a total of 2887 ha, 2790 ha have shown some evidence of BFF occupancy from 1982-84 (Table 1). Studies have been concentrated on the 18 colonies regularly occupied by ferrets ("R" in Table 1, range 12.5 to 1302 ha), but all active colonies have been surveyed, regardless of size. Expansion from the "occupied" area was monitored on a point basis at six small colonies and one ground squirrel *(Spermophilus armatus)* colony adjacent (ca. 1-8 km) to the primary study area. No evidence of BFFs was observed on these colonies during summer spotlight or winter snowtrack searches from 1982-84. However, one ferret was observed on the closest peripheral colony (69 ha) 3.5 km from the nearest occupied colony (T 49 N, R 101 W, Sec. 34) during the winter of 1985 (B. Miller pers. comm.), indicating potential expansion from the known occupied area. Additional searches near prairie dog colonies found along the Greybull and Wood River drainages southeast of the primary study area by Wyoming Game and Fish and USFWS have failed to produce positive ferret sign.

Ferrets have been observed off prairie dog colonies when they are crossing open country to another prairie dog colony and occasionally when they are observed at isolated burrows near colony peripheries. Two dead BFFs have been found and one roadside observation (L. Hanebury, pers. comm.) was made outside the study area and off prairie dog colonies. Search effort expended away from prairie dog colonies has been less consistent and has relied primarily on bisecting tracks across roads and walking gullies where burrows may be present during winters from 1982-85 and spotlighting along roads in the summer. No evidence of BFFs living for any time off colonies has been observed to date. Radio-collared animals have been observed off colonies as mapped, but were always found with small groups of prairie dogs or returned to prairie dog colonies (D. E. Biggins pers. comm.). We assume (as did Hillman et al. 1979 and Linder et al. 1972) that BFFs are confined almost exclusively to prairie dog colonies.

One Meeteetse colony (#11) collapsed of unknown causes between 1982 and 1984, and a second colony (#13) declined in 1984. Other colonies (#25-East Core, #22, and #30) expanded slightly in area (1-5%) and increased in burrow density between 1982-84. Several areas (#17-21) were defined as "scattered" in 1982, but had high enough burrow densities to qualify as "colonies" in 1984.

Prairie dog colonies of 50 ha in the western half of the Bighorn Basin are shown in Fig. 5. Towns less than 50 ha are not included but have been shown to be important to BFFs within the Meeteetse complex. A small complex (Gillies-Murphys Draw; ca. 450 ha) is situated 38 km to the southeast and has not shown conclusive evidence of ferret occupancy in repeated winter and summer searches since 1982.

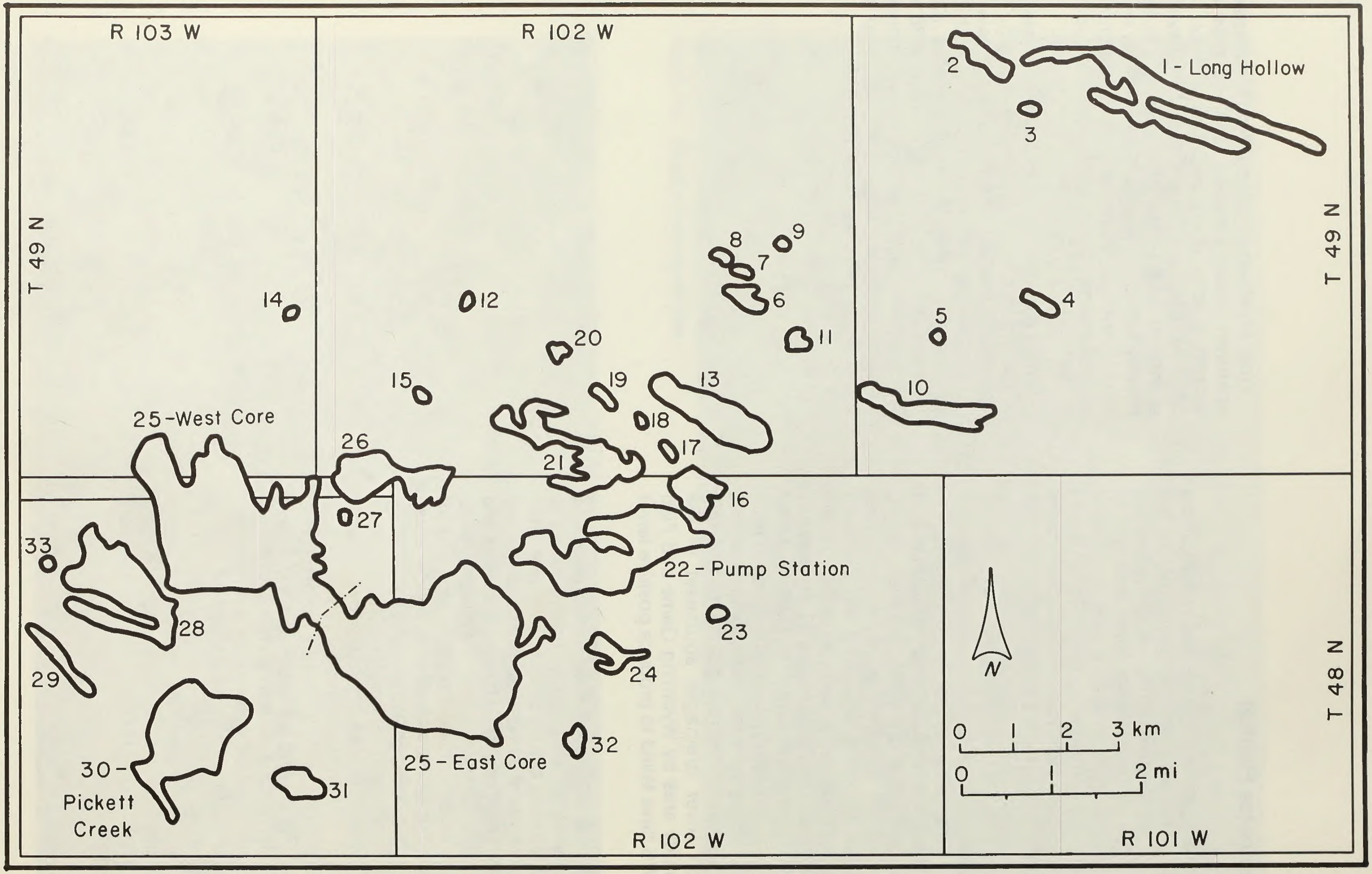

Figure 4. Prairie dog colonies and the Meeteetse study area (1984).

Table 1

Prairie Dog Colony Size and Occupancy History by Black-Footed Ferrets, 1982-84.

Colony number	Colony name	Colony size (ha)	Occupation class[1]	Occupation history[2]															
				1982				1983				1984				1985			
				W	SP	SU	F	W	SP	SU	F	W	SP	SU	F	W	SP	SU	F
1	Long Hollow Corrals	196.5	R	X	X	X	X	X	X	X	X	X	X	X	X	X			
2	Long Hollow West	26.5	NO	-	-	-	-	-	-	-	-	-	-	-	-	-			
3	Long Hollow South	2.5	NO							-				-		-			
4	Lot 58	12.5	R							X	X	X		-		X			
5	Section 30	1.5	NO																
6	Rush Creek Basin	24.0	R					X	X	-		-		-		-			
7	Rush Creek B	3.0	NO					-		-		-		-		-			
8	Rush Creek C	8.5	NO					-		-		-		-		-			
9	Rush Creek D	5.0	NO					-		-		-		-		-			
10	BLM 10	49.5	R			X	X	X	X	X	X	X	X	X		-			
11	BLM 14	20.5	NO			-		-		-		-		-		-			
12	Little Rawhide West	0.5	NO																
13	BLM 13	183.0	R	X	X	X	X	X	X	X	X	X	-	-	X	-			
14	Rawhide West	0.5	NO																
15	Westbrook Draw	2.5	T			-	X	-		-		-				-			
16	Lower BLM	50.5	R	X		-		X	X	X	X	X	X	X	X	X			
17	Little Rawhide #1	1.0	NO											-		-			
18	Little Rawhide #2	2.0	NO											-		-			
19	Little Rawhide #3	6.0	T											-		X			
20	Little Rawhide Basin	9.0	NO											-		-			
21	Rawhide	102.0	R											X		X			
22	Pump Station	230.0	R	X	X	X	X	X	X	X	X	X	X	X	X	X			
23	Tonopah	31.5	R	X	X	-		X		-		-		-		X			
24	Thomas'	31.5	R	X	X	-		X	X	X	X	X	X	X	X	X			
25 EAST	East Core	738.5	R	X	X	X	X	X	X	X	X	X	X	X	X	X			
25 WEST	West Core	568.5	R	X	X	X	X	X	X	X	X	X	X	X	X	X			
26	91 Town	97.5	R	X	X	X	X	X		-		X	X	X	X	X			
27	Fence	0.5	T					X		-		-		-					
28	Rose Creek	158.0	R	X		-		X	X	X	X	X	X	X	X	X			
29	Island	21.0	R			-		X		-		X		-		-			
30	Pickett Creek	211.0	R	X	X	X	X	X	X	X	X	X	X	X	X	X			
31	Graveyard	51.5	R			-		X	X	X	X	X	X	X		X			
32	Hogg	30.5	R	X		-		X		-		X		-		X			
33	Rose Creek West	9.5	T					-		-				-		X			
TOTAL		**2886.5**																	

---

[1] R=regularly occupied
T=temporarily occupied
NO=no record of occupancy

[2] X=occupied
-=surveyed but not occupied
(blank)=not surveyed (no data)

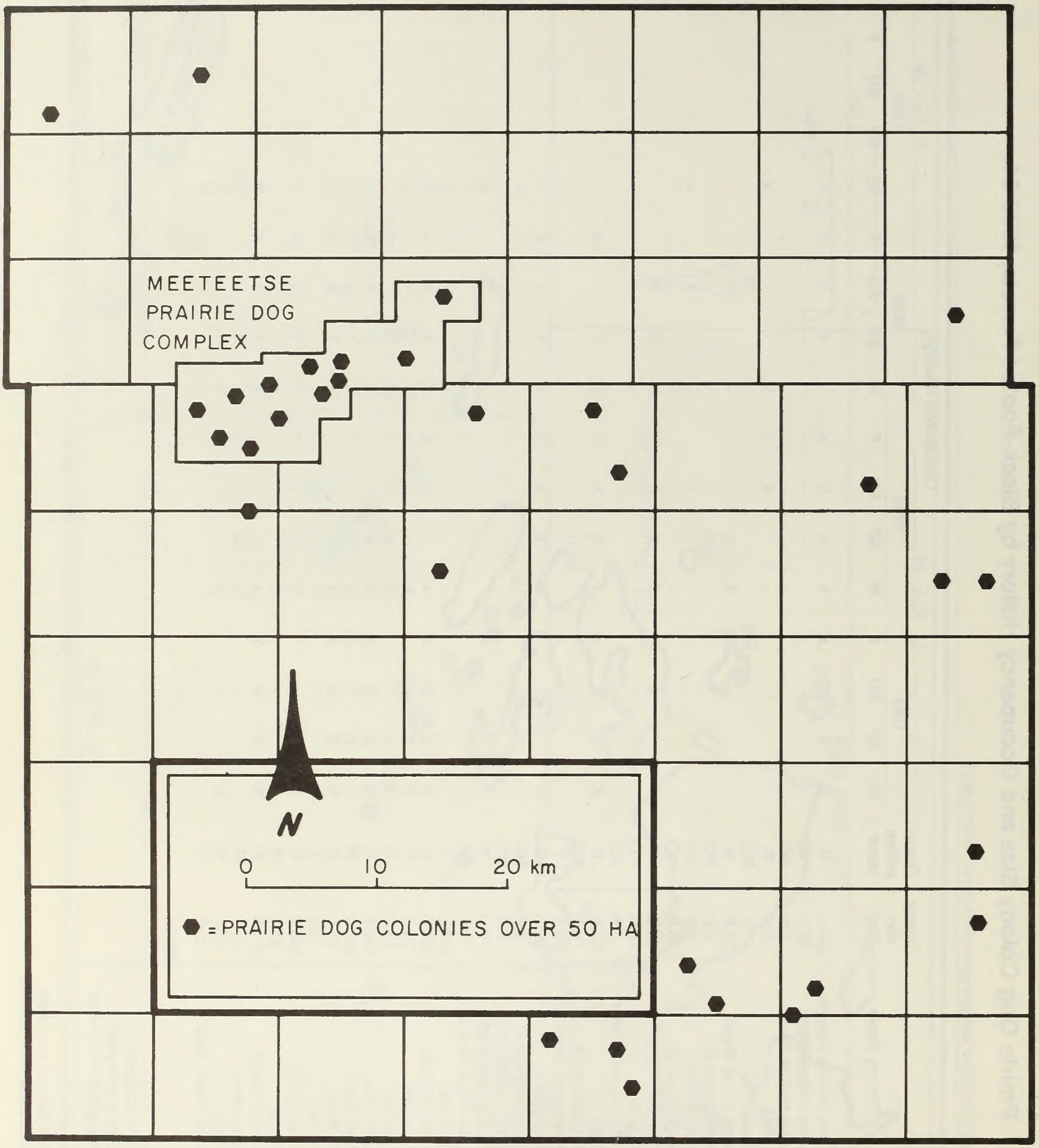
MEETEETSE PRAIRIE DOG COMPLEX
N
0
10
20 km
● = PRAIRIE DOG COLONIES OVER 50 HA

Figure 5. Prairie dog colony distribution, southeast Bighorn Basin.

HABITAT ATTRIBUTES

Because of the dependence of BFFs on prairie dogs, a relationship exists between these two species which is simpler than many carnivore/prey systems occurring in more variable environments. Because prairie dogs and BFFs occur sympatrically, BFF habitat attributes can be expressed by prairie dog colony attributes (sizes, densities of occupation, etc.). This section presents a summary of several features of the Meeteetse BFF habitat and their relationship to BFF distribution. Comparative biology with other mustelids supports our inferences about BFFs where data are lacking.

Areas Used by BFFs

Knowledge of the size of an area needed by an individual BFF to meet its ecological and behavioral requirements is needed to estimate the sizes of prairie dog colony complexes required to support viable BFF populations. We do not yet have precise year-round data on BFF movements and area use, but seasonal data are available for a few animals. We also have estimates of BFF distribution among colonies at Meeteetse for three breeding seasons from 1982-84 and have associated 51 individuals with colonies during this time. Thus, we can infer how BFFs use space at Meeteetse and estimate areas needed to establish viable populations of BFFs (ha/BFF).

Among extant carnivores, mustelids most closely represent the primitive carnivore stock (Ewer 1973, Radinsky 1981a,b). Because primitive carnivores lead solitary lives, females in these species bear the entire energetic burden of gestation, lactation, and rearing. In the mustelids, this has led to differences in body size between sexes and a high degree of intrasexual competition. Polygynous mating in many of these species has led to different spatial strategies as each sex tries to maximize different critical resources: females attempt to maximize access to food (energy) for rearing young, and males attempt to maximize access to females first and access to food second (Ewer 1973, Powell 1979, Wittenberger 1981, Lott 1984). A model by Schoener and Schoener (1980) proposed that territory size for the adult male of a polygynous species should maximize access to females and found from supporting field data (Schoener 1983) that female density increased with habitat quality while male density remained relatively constant. It follows that if either access to females or food is limited, that competition between individuals for those resources will result in avoidance or exclusion for some individuals (Kruuk 1978).

Mustelids exclude members of the same sex from areas they use either in time or in space (Lockie 1966, Erlinge 1977, Powell 1979). This behavior pattern is illustrated in wild European fitch ferrets *(M. furo*. a close relative of *(M. nigripes)* in New Zealand (Moors and Lavers 1981). Juvenile fitch ferret females are tolerated within their own mothers former ranges, but seldom overlap each other spatially. Juvenile male recruits are only tolerated at the periphery of resident male ranges, and resident males appear to adjust their range boundaries to avoid overlap with them. Resident males avoid overlap with other resident males. Resident females occasionally have small spatial overlaps, but never overlap temporally. Moors and Lavers (1981) also found that females used smaller ranges (12.4 ha) and were overlapped by males using larger ranges (31.3 ha), further supporting the hypothesis of space use by polygynous species.

BFFs lead a solitary existence, except for the period when mother and young are together. BFFs are probably polygynous, and follow intrasexual spacing patterns of other polygynous species. Richardson et al. (in prep) and Biggins et al. (1985) noted that areas used by snow-tracked and radio-tracked male BFFs are much larger than areas used by female BFFs. A resident female snow-tracked from 20 December 1983 through 31 March 1984 used 16.0 ha and was overlapped by a resident male which used 136.6 ha during roughly the same period. The activity area of a young radio-collared female (12.6 ha, 30 October 1982 to 14 November 1982) was less than half the area used by an adult male (27.5 ha, 30 October 1981 to 14 November 1981). A radio-collared resident male in the fall of 1983 overlapped areas where we earlier observed four females with litters (Biggins, pers. comm.).

If male BFFs use areas much larger than needed to obtain food, then females use areas which probably more closely represent the amount of space needed by an individual to meet its physiological needs. When discussing average area use by BFFs, it is evident that sexes use space differently. However, even if we knew with some confidence what the average space use of each sex was, we would still not know how to distribute sexes among the space. Therefore, the most appropriate method of assessing BFF density is to observe how BFFs are distributed over known areas.

Habitat boundaries are well defined at Meeteetse, but we do not know how many BFFs will or can fill this known habitat. We have observed population peaks after the appearance of young above ground in the summer. Through the fall and winter, 50-75% of both young of the year and older animals "disappear" (emigrate or die; Forrest et al. 1985). From the late March breeding season (Carpenter and Hillman 1978), the number of "resident" animals then remains about the same (with a small amount of disappearance) through the following summer. The resident population count, which varies yearly, is influenced by factors such as ferret survivorship, which may be related to annual variation in prairie dog densities (see Fig. 11). The spring and summer probably represent the period of least population change, and these "adults" effectively represent the "breeding" population for that year.

We can estimate average adult BFF density from the maximum number of resident adult BFFs observed in either spring or summer from 1982 to 1984 (BFFs are assumed resident if they survive to the breeding season in spring or we can assume their presence during spring by their presence in summer counts). Maximum spring-summer counts for all colonies are shown in Table 2. We used 2886.5 ha as the total available habitat (Table 1) to estimate the average BFF density even though some small colonies showed no evidence of occupancy. To estimate maximum BFF densities, the four colonies which showed the highest density of resident adult BFFs and breeding females (from the presence of litters) were used.

The average density of adult ferrets at Meeteetse using all available habitat is 1 BFF/56.6 ha. The mean density of adult BFFs on occupied colonies only is one BFF/54.5 ha (± S.D. 26.6). The four colonies most densely occupied by BFFs with litters (#25 West Core, #22 Pumpstation, #30 Pickett, #28 Rose) have a mean density of one adult BFF/41.8 ha (S.D. ± 4.0). Of the 16 colonies with long-term occupancy (Table 2), seven are occupied at BFF densities of one adult/38-52 ha. A young female radio-tracked from 22 September to 5 November 1982 used 52.95 ha (Biggins et al. 1985) and it is also interesting to note that the ferret found outside the known area in 1985 was using a 69 ha colony. Table 2 shows the variability of ferret density by colony, but on average ferrets are distributed at Meeteetse at one BFF for every 40-60 ha. As a rough estimate from these data, each additional 50 ha of colony or complex should support one additional adult BFF.

Quality of Areas Used by BFFs

Resource quality may also affect space use by mustelids (Schoener 1983, Moors 1974). Moors and Lavers (1981) noted a reduction in the size of areas used by female *M. furo* where prey was abundant. We do not have a measure of how prey density varies spatially at Meeteetse, but we do know that burrow densities vary within colonies, and that burrow densities are correlated with the number of prairie dogs present (Fig. 6, r=0.71, n=12, P is less than .05). Areas of relatively high burrow density provide a greater number of opportunities for BFFs to escape predators, find cover, and minimize time spent above ground away from protection than in areas where burrows are far apart.

We examined BFF use of areas of differing burrow densities to measure the effect of this habitat variable on space use. The average burrow densities were recorded within the activity areas used by 21 BFFs snow-tracked for three consecutive activity periods (Fig. 7). Size of activity area was found not to be a function of burrow density using a test of the regression coefficient (b=-0.31, n=21, ts=-1.5733, P is less than .05). However, males and females are lumped in this analysis, which could mask any effect of burrow density on area use by females, who should theoretically respond more to differences in prey or burrow density. This does not exclude the possibility that BFFs could occupy higher quality habitat at higher densities (e.g., dense black-tailed prairie dog colonies). However, it does not conclusively support a case that denser burrow openings strongly influence the areas used by ferrets.

However, high burrow densities may be desirable for the added protection they provide. An influence on space use and reduced protection may only be felt when burrow densities are lower than observed here, which range from 10-100 burrows/ha.

Table 2

Maximum Numbers of Black-Footed Ferrets Observed on Colonies During Spring and Summer Counts, 1982-1984

Colony Number	Colony Name	Max. no. of adult "resident" BFFs Observed, 1982-84	Max. no. of females with litters	Density hectares/ BFF
1	Long Hollow Corrals	3 (SU 82)*	2	65.5
2	Long Hollow West	0		0
3	Long Hollow South	0		0
4	Lot 58	1 (SU83)		12.5
5	Section 30	0		0
6	Rush Creek Basin	1 (SP 83)		24.0
7	Rush Creek B	0		0
8	Rush Creek C	0		0
9	Rush Creek D	0		0
10	BLM 10	1 (SU 83,84)	1	49.5
11	BLM 14	0		0
12	Little Rawhide West	0		0
13	BLM 13	2 (SP 82)	1	91.5
14	Rawhide West	0		0
15	Westbrook Draw	0		0
16	Lower BLM	1 (SU 83,84)		50.5
17	Little Rawhide #1	0		0
18	Little Rawhide #2	0		0
19	Little Rawhide #3	0		0
20	Little Rawhide Basin	0		0
21	Rawhide	1 (SU 84)		102.0
22	Pump Station	6 (SU 84)	4	38.3
23	Tonopah	1 (SP 82)		31.5
24	Thomas	I (SU 83,84)		31.5
25 EAST	East Core	10 (SP 84)	6	73.8
25 WEST	West Core	12 (SU 84)	7	47.4
26	91 Town	1 (SU 82,84		97.5
27	Fence	0		0
28	Rose Creek	4 (SU 84)	3	39.5
29	Island	0		0
30	Pickett Creek	5 (SU 84)	4	42.2
31	Graveyard	1 (SU 83,84)	1	51.5
32	Hogg	0		0
33	Rose Creek West	0		0
TOTALS		**51**	**29**	

*SU=Summer
SP=Spring

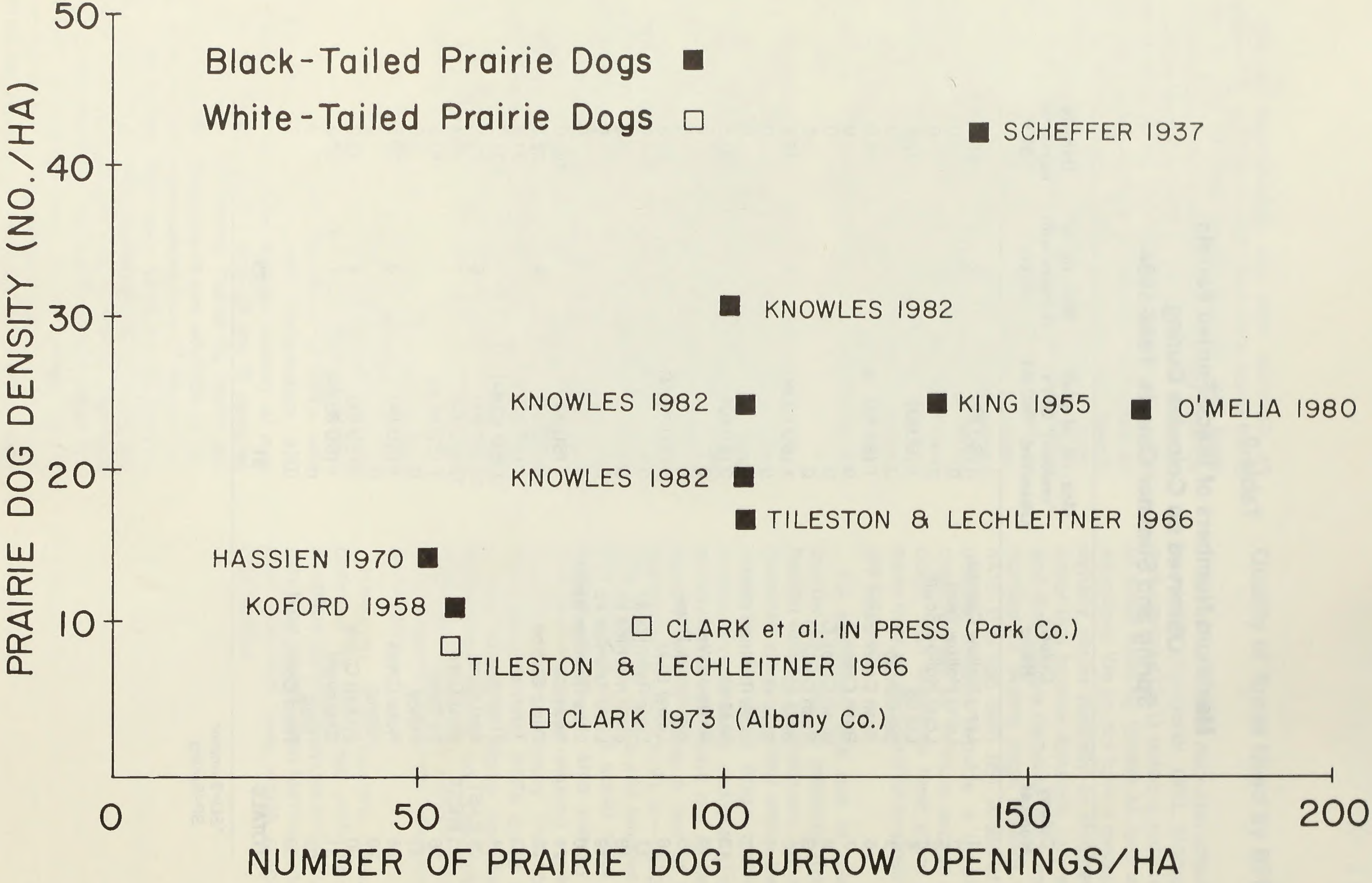

Figure 6. Relationship of prairie dog density to prairie dog burrow density, major studies.

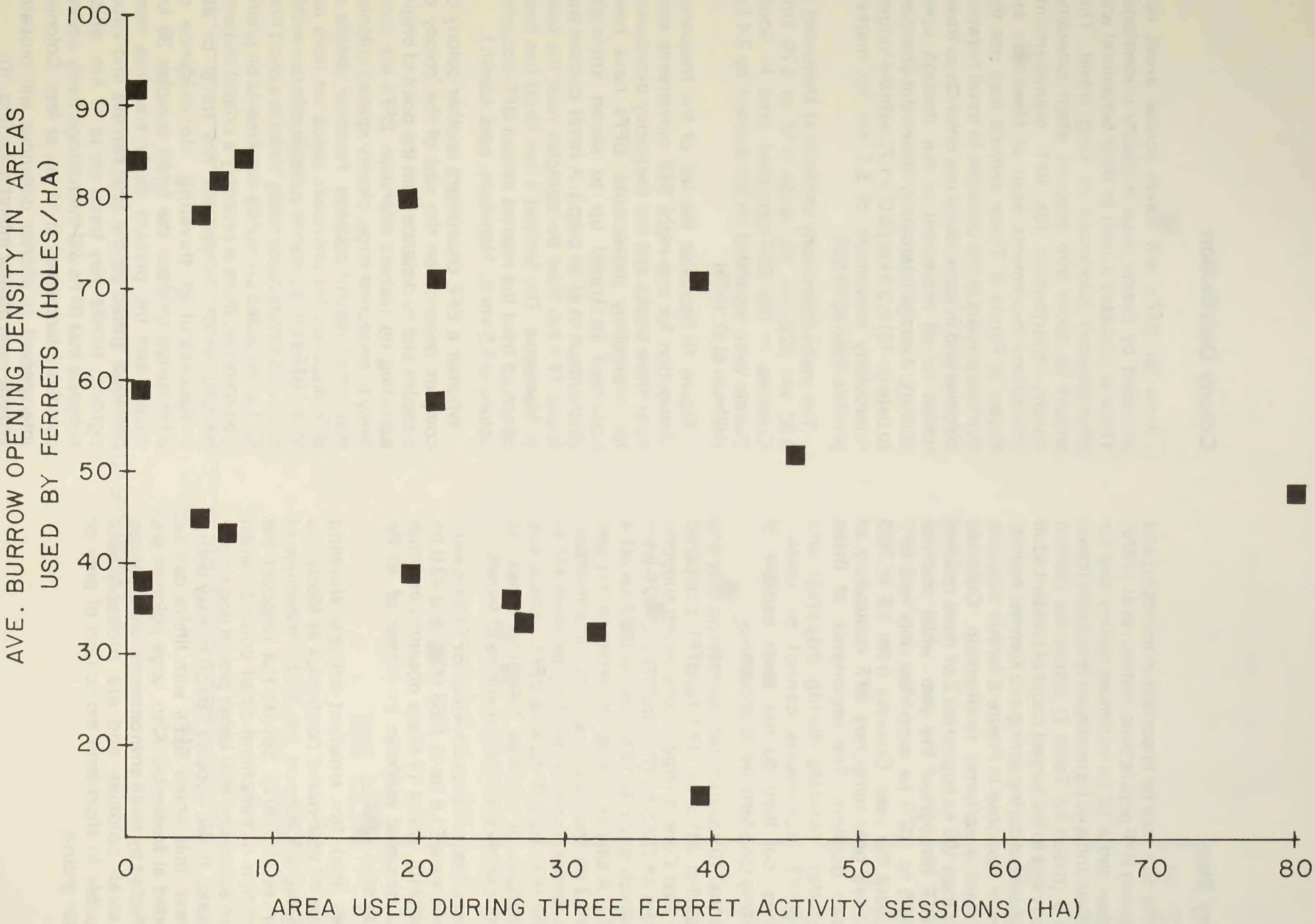

Figure 7. Relationship of prairie dog burrow density to areas used by BFF during 3 consecutive activity sessions.

Colony Size

Colony size may be important in attracting and maintaining BFF populations. Hillman et al. (1979) recommended a 12 ha minimum colony size for individuals and a 40 ha minimum to support litters. Figure 8 (based on Table 2) shows the relation of colony size to the largest count of resident adult BFFs observed during spring and summer counts. The linear response in Figure 8 further supports a constant area/ferret relationship. Colonies greater than 100 ha supported 2 or more resident adult BFF throughout the year, while colonies from 12.5 to 102.0 ha supported only one BFF throughout the year. Colonies from 2.5 to 30.5 ha showed only temporary BFF occupancy of unknown duration. The importance of these "peripheral" habitats during dispersal and intercolony movements cannot be underestimated, but they do not seem capable of supporting long-term ferret occupancy.

Note that 10 colonies each supporting only one BFF totalled 491.0 ha (49.1 ha/BFF), compared to #25-East Core, a large colony which supports 10 ferrets on 738.5 ha (73.8 ha/BFF), or #25-West Core, which supports 12 ferrets on 568.5 ha (47.4 ha/BFF). A similar number of ferrets (n=11) was supported on combinations of four intermediate-sized colonies, variously totalling between 441 to 609.5 ha (40.1 ha/BFF-55.4 ha/BFF). Various size combinations of colonies therefore appear to support roughly equivalent numbers of ferrets.

The smallest colonies on which BFF litters were observed were 51.5 ha in 1983 (#31) and 49.0 ha in 1984 (#10). Six of 11 litters observed in South Dakota occupied colonies in excess of 40 ha (Hillman et al. 1979).

Given that the smallest colony showing evidence of year-round occupancy at Meeteetse is 12.5 ha, we support the 12 ha minimum of Hillman et al. (1979), but do not discount the contribution of peripheral small colonies when they are associated with larger prairie dog colony complexes. It also appears that 50 ha may define the lower limit where BFFs with litters can be supported at Meeteetse. Also, large colonies are less affected by small environmental disturbances than small colonies and are probably less susceptible to short-term extinctions of prey or predator groups.

Colony Distribution

How far BFFs will travel across areas not occupied by prairie dogs is poorly understood. There is probably a limit to their behavioral and physiological tolerances to long travel. This should be taken into account when assessing colony distribution for BFF management. Intercolony movements seen at Meeteetse are shown in Figure 9. These animals may use the burrows present at low densities to travel between colonies and in some cases use colonies as travel routes so all movement is not through open country. Average intercolony movement observed to date (n=15) is 2.5 km (S.D. +1.7), with the longest intercolony movement of 5.7 km by marked juvenile male #519-520.

The mean intercolony distance at Meeteetse is 0.92 km (S.D. ± .79, range 0.13 to 3.70 km). Colonies in the BFF-occupied area in South Dakota were separated on the average by 2.4 km (Hillman et al. 1979).

Figure 10 indicates the tail of the frequency distribution for one-night BFF movements seen from snow tracks and the frequency distribution for intercolony movements. BFFs have been observed to travel up to seven km/night (Richardson et al. in prep.). A ferret carcass was found 11.1 km from the complex near the town of Meeteetse. The farthest a live ferret has been observed from the nearest known BFF-occupied colony is 5.5 km (L. Hanebury, pers. comm.).

Whether a BFF encounters another colony or complex depends on the size of the colony or complex and its distance from the point of origin, assuming no barriers intervene. BFFs are more likely to encounter large, closely spaced colonies than small, distant colonies. However, details of BFF dispersal are unknown. Since we have not found BFFs on apparently suitable colonies within distances ferrets could easily travel in a short time (2-3 days) based on nightly movements on prairie dog colonies, there is probably a critical distance beyond which ferrets will not travel or are unsuccessful at traveling. No evidence of interchange between the small complex 38 km distant and the primary study area has been observed. Based on the BFF carcass and visual sighting, ferrets may travel up to 17 km, which suggests that BFFs will interchange freely among colonies interspersed at 17 km or less. Colonies interspersed at shorter distances will probably provide even greater interchange (Fig. 10).

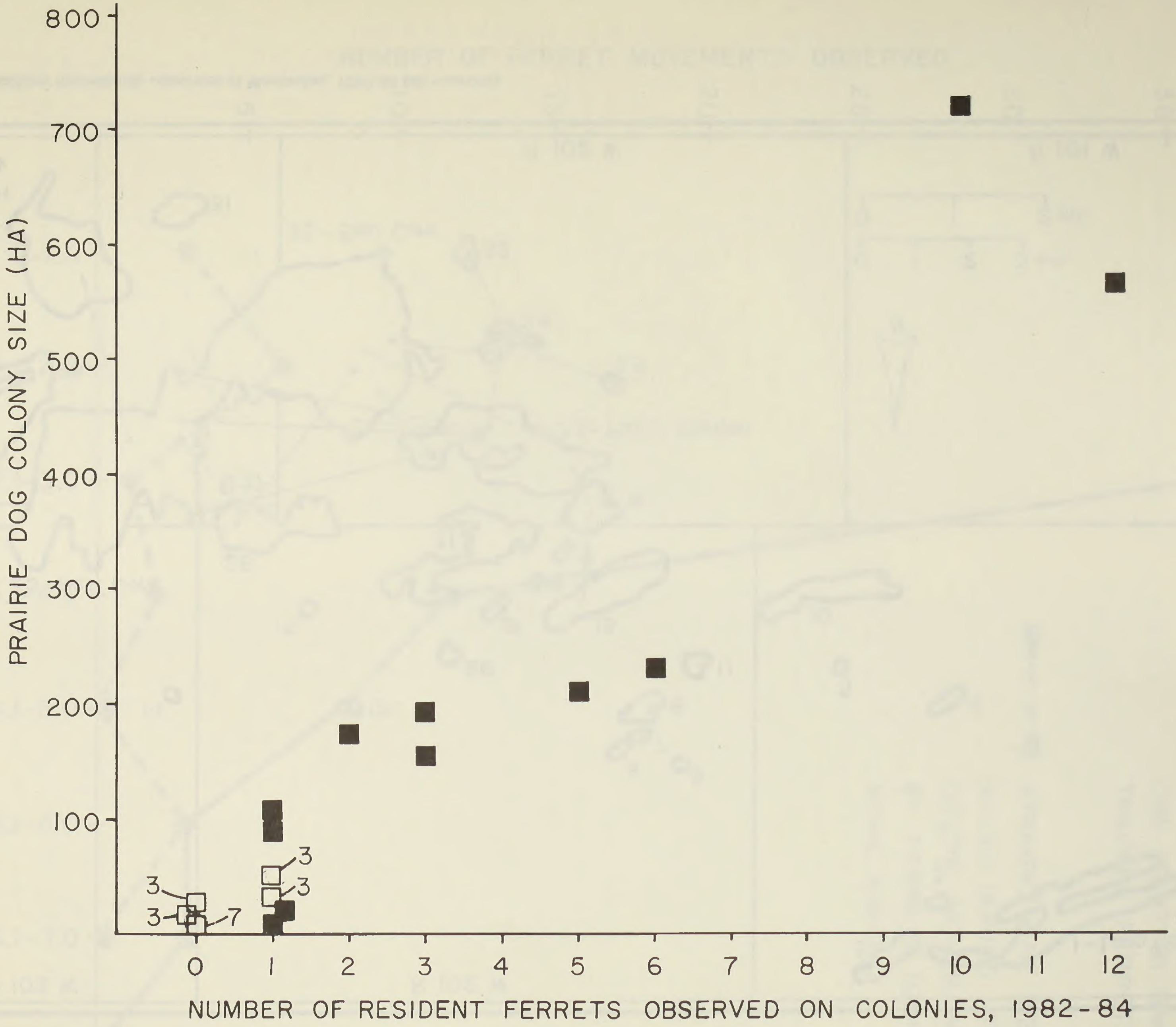

Figure 8. Relationship of colony size to the maximum number of resident BFF observed on them, 1982-84.

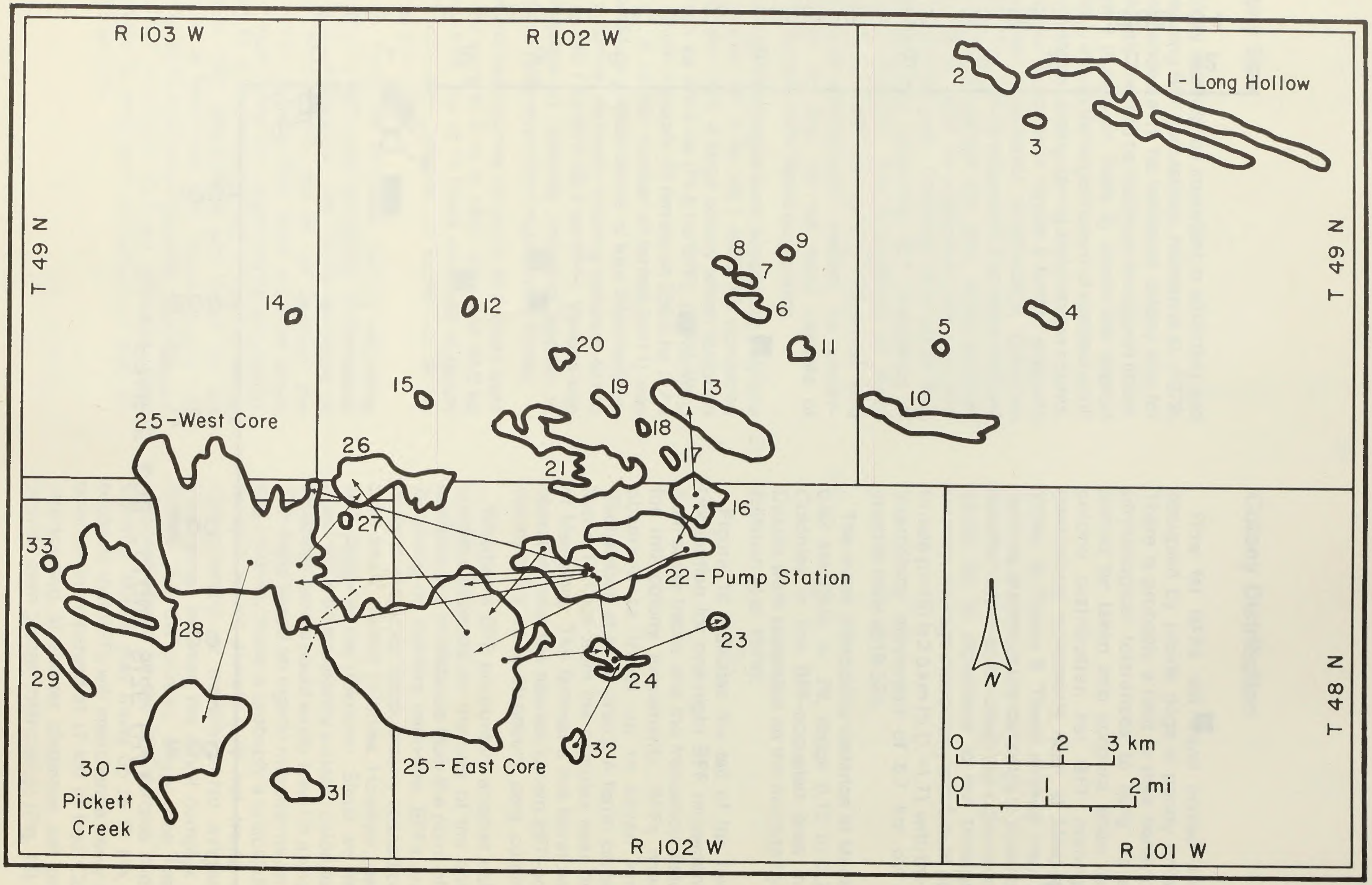

Figure 9. Intercolony movements observed at Meeteetse, 1982-84 (all sources).

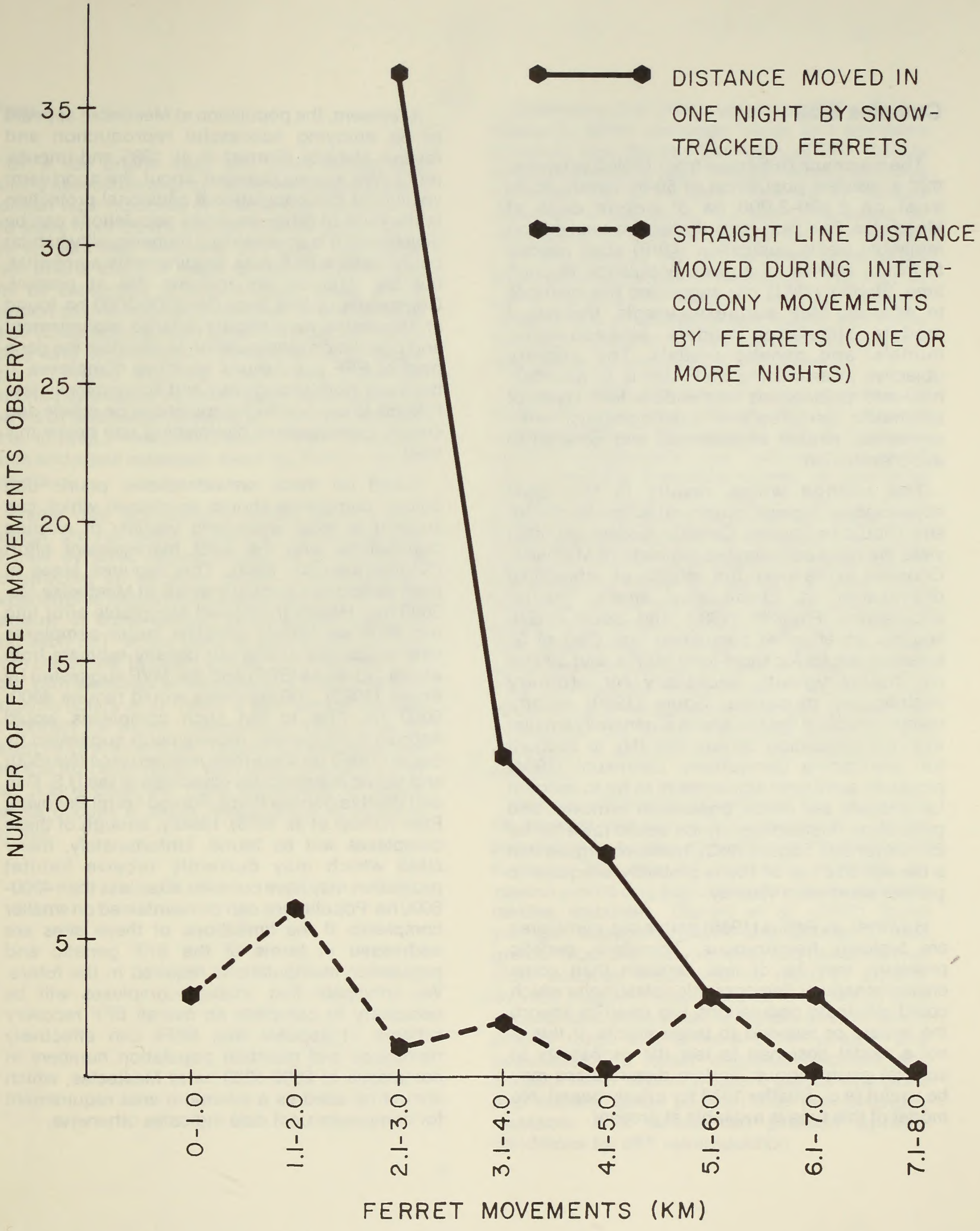

Figure 10. Partial frequency distribution of long single-night movements and known intercolony movements, 1982-84.

Complex Size

The maximum BFF count from Table 2 estimates that a resident population of 50-60 ferrets could exist on 2,500-3,000 ha of prairie dogs at Meeteetse. Few long-term studies are available on minimum viable population (MVP) sizes needed to insure survival of a given population through time. Shaffer (1981) has suggested five methods to estimate MVP size: experiments, theoretical models, simulation models, biogeographic models, and genetic models. The primary objective in estimating MVP size is to ascertain how well populations can endure four types of stochastic perturbations (demographic, environmental, natural catastrophic, and genetic) to avoid extinction.

The method which results in the most conservative (highest minimum) estimate of MVP size should be chosen. Genetic models will often yield the most conservative estimate of MVP size. Concern exists over the effects of inbreeding depression in chronically small, insular populations. Franklin (1980) and Soule (1980) suggest an effective population size (Ne) of 50 breeding adults for short-term MVP's, and 500 for the heterozygosity necessary for ordinary evolutionary processes. Soule (1980) recommends doubling the Ne, which is generally smaller than the population census size (N), to account for overlapping generations. Lehmkuhl (1984) proposes additional adjustments to Ne to account for unequal sex ratios, population turnover, and population fluctuations, which would raise Ne for BFFs over 200. Foose (1983), however, argues that a census size (N) of 100 is probably adequate to protect short-term viability.

However, as Pettus (1985) points out, carnivores are typically homozygous. Therefore, genetic problems may be of less concern than some environmental or demographic catastrophe which could eliminate populations too small to absorb the impact or respond to those events. If this is so, a model designed to test the probability of survival given various random disturbances may be useful (e.g., Shaffer 1978 for grizzly bears). No model of this type is available at present.

At present, the population at Meeteetse appears to be enjoying successful reproduction and relative stability (Forrest et al. 1985 and unpubl. rept.). We are encouraged about the short-term viability of this population if additional protection in the form of other, separate populations can be developed. It is possible that higher quality habitat could reduce BFF area requirements somewhat, but the data do not indicate this at present. Complexes of less than the 2500-3000 ha found at Meeteetse may require intense management and population manipulation to maintain the gene pool of BFF populations on those complexes. It becomes both biologically and economically less feasible to support BFF populations on prairie dog colony complexes of diminishing size below this level.

Based on these considerations, prairie dog colony complexes should be chosen which can support at least short-term viability of existing populations with the least management effort (Shonewald-Cox 1983). This requires areas at least as large as currently exists at Meeteetse (ca. 3000 ha). However, to build acceptable error into the MVP, we should consider larger complexes where possible. Using our density estimate from above (40-60 ha/BFF) and the MVP suggested by Foose (1983), 100 residents would require 4000-6000 ha. Five to ten such complexes would approach the genetic requirements suggested by Soule (1980) for long-term maintenance (Ne=500) and would approximate objectives of the U.S. Fish and Wildlife Service Black-Footed Ferret Recovery Plan (Linder et al. 1978). Ideally, enough of these complexes will be found. Unfortunately, many sites which may currently receive habitat protection may have complex sizes less than 4000-6000 ha. Populations can be maintained on smaller complexes if the limitations of these sites are addressed in terms of the BFF genetic and population manipulations required in the future. We anticipate that smaller complexes will be necessary to complete an overall BFF recovery scheme. It appears that BFFs can effectively reproduce and maintain population numbers in complexes of 2500-3000 ha at Meeteetse, which should be used as a minimum area requirement for complexes until data indicates otherwise.

Prey

BFFs use prairie dogs and other prairie dog colony associates as prey. Scats we have analyzed contain high numbers of prairie dog remains, as did scats from South Dakota (Sheets et al. 1971). We suspect that whenever BFFs are associated with prairie dogs, a major portion of BFF diets will be composed of prairie dogs. Areas which support prairie dogs also maintain populations of mice (Cricetids), ground squirrels *(Spermophilus* spp.) and lagomorphs *(Sylvilagus* and *Lepus* spp.). Ground squirrels, mice, and cottontail rabbits *(Sylvilagus nuttallii)* have been taken by ferrets at Meeteetse (Clark et al. 1985, Richardson et al. in prep.). Henderson et al. (1969) described birds and small mammals taken by BFFs in South Dakota.

Prairie dog populations, which provide BFF habitat, are not easily quantified, partly because of their dynamic nature. Powell et al. (In press) constructed an additive model of BFF energy expenditures based on *M. eversmanni* and activity patterns of snow-tracked BFFs which indicated that each BFF would need to eat 20 prairie dogs from December through March, or about 104 kcal/day. With densities at Meeteetse of 3.5-9.3 prairie dogs/ha (Clark et al. 1985), a BFF should be able to extract its winter requirement from three to seven ha of prairie dogs. This model assumes that there is no competition with other predators and that prairie dogs are 100% vulnerable. In reality ferrets occupy a larger home range to account for this.

Stromberg et al. (1983) estimated BFF densities based on ferret metabolic needs and estimates of prairie dog density. Estimates of BFF density based on characteristics of black-tailed prairie dog colonies (37-95 ha/BFF) fall within ranges observed at Meeteetse, but estimates based on characteristics of white-tailed prairie dog colonies (167-355 ha/BFF) are two to three times larger than ranges observed at Meeteetse. This may be partly explained by the relatively high densities of white-tails at Meeteetse (see Fig. 6), and it may be partly explained by assumptions in the model (e.g., alternate prey are not considered).

Erlinge (1983) has called for more background data on prey populations for an overall understanding of demography and dynamics in mustelid populations. For example, Figure 11 shows changes in burrow counts on four plots on #25-East Core from 1982 to 1984. A trend analysis has not been performed on these data, but it appears that burrow densities have been increasing overall since beginning these counts. We mentioned earlier that prairie dog populations have declined on two other colonies. Fluctuating prairie dog numbers probably greatly influence BFF distribution. Although we have described some physical habitat features in detail because they are readily measureable, we have not systematically measured prairie dog populations throughout the entire Meeteetse complex. But obviously, a healthy prairie dog population is requisite.

Stability of the prey population is also important. Of greatest concern is the susceptibility of the population to sudden and catastrophic decline or collapse. No data are currently available on various prairie dog population structures and their relative stabilities. Garrett et al. (1982) found younger, expanding prairie dog colonies to have greater fecundity, survivorship, and densities than older colonies which had no room to expand. Sylvatic plague (*Yersina pestis*) is known to have caused total population collapses in Gunnison's prairie dogs and afflicts other prairie dog populations to lesser degrees (Hubbard and Schmitt 1984). Where frequent plague outbreaks are known, prey populations are probably unstable and would not provide optimal conditions for BFF reintroduction.

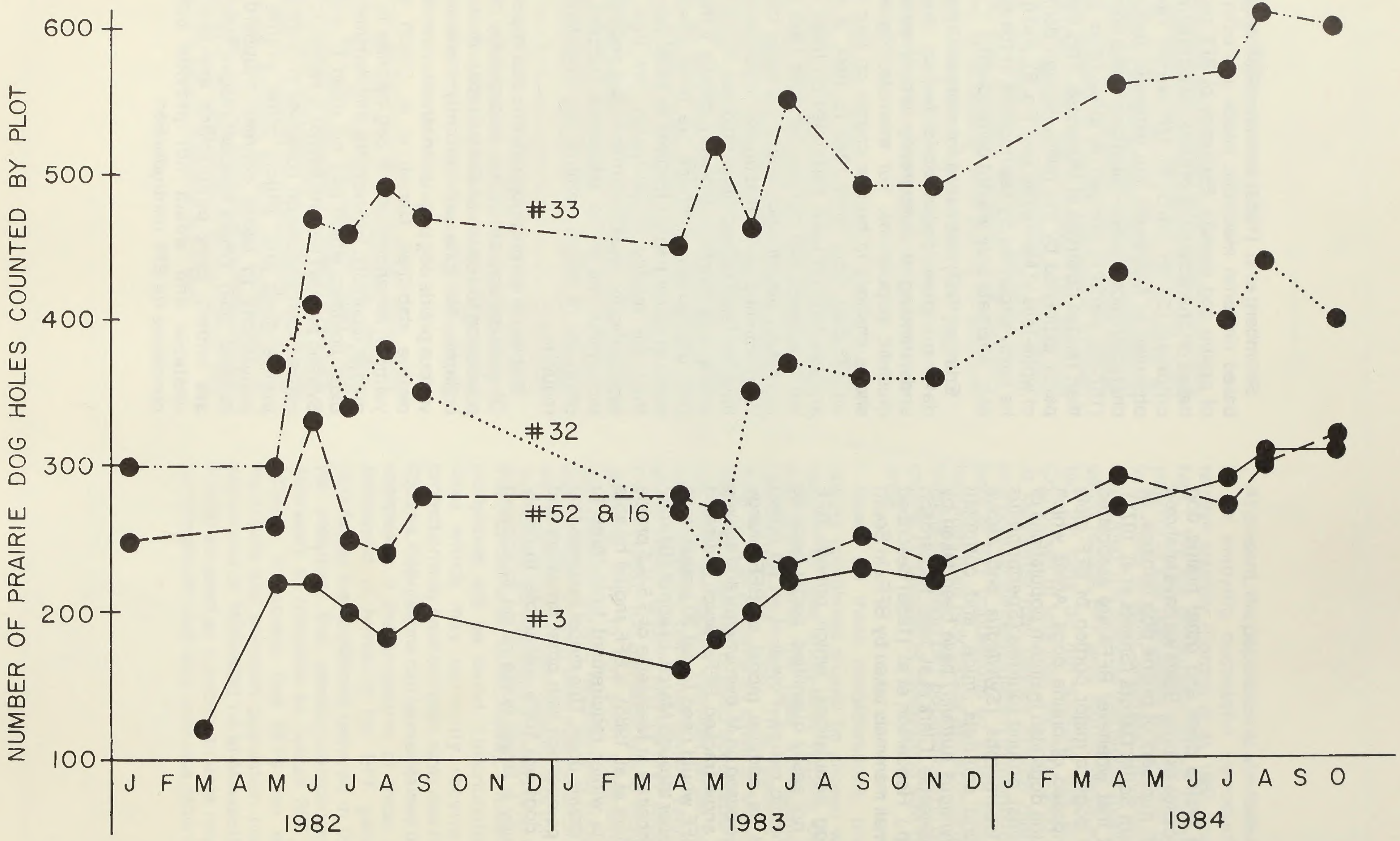

Figure 11. Changes in prairie dog burrow openings on 4 plots, 1982-84.

Related Factors

Vegetation

While a relationship between prairie dogs and vegetative composition exists, BFFs appear less influenced by differences in vegetation than by the presence of prairie dogs. Since prairie dog occurrence and density may be more dependent on factors such as human disturbance and prairie dog social behavior, vegetative parameters appear less descriptive of BFF habitat than other variables (Collins and Lichvar 1984).

An interpretation that shrubby habitats may exclude BFFs is not supported by Collins and Lichvar (1984), who found significant differences in structural complexity (shrubbiness) among prairie dog colonies in Wyoming where BFF skeletal remains have been found.

Burrow Structure

We have described four major burrow structures at Meeteetse: mounded (excavated subsoil surrounds 2/3 of the circumference of the hole, often with multiple entrances), non-mounded (entrance flush with topography, often vegetated for greater than 1/3 of circumference), and mounded and non-mounded holes excavated by badgers *(Taxidea taxus)* to a depth of 0.5 m or more.

Litters observed above ground in July were always associated with mounded burrows, the majority of these having multiple entrances, despite the fact that non-mounded burrows occur nearly three times as often as mounded burrows on #25-East Core (Richardson et al. in prep.). We suspect that large mounded burrows represent an extensive and deep burrow system not readily accessible to other fossorial predators (e.g., badgers), which makes them important for successful rearing of young. Litters are frequently moved by the mother to other mounded burrows within her use area, although reuse of some burrows has been noted. A number of mounds may be requisite or desirable for rearing BFF young.

Stromberg (1975) suggested that complex burrows (those with more than two entrances) which developed on older, established prairie dog colonies, might be a general requirement for BFFs. This conclusion was based on Sheets' et al. (1971) excavations of BFF-occupied burrows which were of the multiple entrance type. Stromberg (1975) found with few exceptions simple (single entrance) burrows on the "new" colonies he studied. At present, no evidence exists to suggest that BFFs will not occupy simpler burrow systems if complex burrows are not available, although our observations suggest they may be preferred.

Predators

Predation on BFFs by both avian and terrestrial predators has been documented at Meeteetse (Forrest et al. 1985). The following potential predators have been observed on prairie dog towns in the Meeteetse area: badgers, bobcats *(Lynx rufus)*, coyotes *(Canis latrans)*, red fox *(Vulpes vulpes)*, golden eagles *(Aquila chrysaetos)*, great horned owls *(Bubo virginianus)*, and ferruginous hawks *(Buteo regalis)*, very similar to the predator composition observed in South Dakota (Henderson et al. 1969). That similar predator species are found around prairie dogs in many other areas (Clark et al. 1982) suggests that it is probably not crucial to figure predators into the selection process for reintroduction sites unless there is reason to suspect they occur at very high densities.

MANAGEMENT CONSIDERATIONS

We now summarize BFF habitat features and give recommendations for assessing the biological suitability of prairie dog distributions to support populations of BFFs. It should be noted that many factors other than biological parameters will influence the ultimate design and choice of BFF habitat reserves. The following are listed in the order of importance for consideration:

(1) Complex size—The most important attribute of BFF habitat is the distribution and abundance of prairie dogs; those present and their potential for expansion. We estimate that approximately 40-60 adult BFFs are supported on 2500-3000 ha of white-tailed prairie dogs using 10 or more burrows/ha at Meeteetse. Individual ferrets occur at about one BFF/40-60 ha of prairie dog colony. Although burrow density is one measure of habitat quality relating to both cover and food needs of BFFs, it does not appear to vary the size of areas used by Meeteetse BFFs. However, area use may be affected where prairie dogs occur at very low densities. Even with large complexes several BFF populations will be required to assure long term viability for total recovery of the species. Ideally, we would like to find or translocate BFF populations to sites having the maximum possible habitat, but recognize that combinations of reserves in the smaller size classes (2500-3000 ha) will make up a portion of the total recovery scheme. In general, complexes should be identified which are equal or greater in size to the Meeteetse example.

(2) Colony size—Each colony used in computing the complex area should be 12 ha or greater, which is the smallest area known to be persistently occupied by ferrets at Meeteetse. Colonies of a minimum 50 ha appear necessary for each breeding female, and therefore the majority of colonies comprising the total complex should be 50 ha or greater.

(3) Colony distribution—The distances between colonies within the colony complex should not exceed 20 km. As a rule, most colonies in the complex should be separated by the distance a ferret could travel in one night, or less than seven km. The more closely spaced colonies are, the greater potential interchange of ferrets among them.

(4) Prey—The numbers or demographics of prairie dog populations required to sustain BFF populations are unknown. The most unstable situation presently known is the occurrence of sylvatic plague, which could cause collapse of the prey base. Areas with a history of recurrent plague outbreaks should be avoided.

(5) Vegetation—Vegetation does not appear to influence the distribution of BFFs.

(6) Burrow structure—At present, we have no evidence to recommend a distinction between "new" (less complex) and "old" (more complex) burrows with regard to BFF occupancy.

(7) Predators—Predators should not eliminate a colony complex from consideration unless they occur at very high densities. Predator reduction may be an option prior to BFF reintroduction.

In evaluating potential BFF habitat, the manager should have a current inventory of prairie dog colonies in all areas considered, including adjacent colonies under other management jurisdiction which could complete the complex. All prairie dog colonies should be accurately and consistently mapped. If areas exist which could potentially be occupied by prairie dogs in the future, this should be noted, if management objectives include expanding the prairie dog base.

An example of a hypothetical complex designation is shown in Figure 12. The prairie dog colony distributions are grouped into two complexes based on colony size and colony interspersion. Colonies which may be large enough to support some ferrets but are extremely isolated are not included in a designation, while even very small colonies closely associated with other large colonies can form complexes large enough to potentially support BFF populations. Complexes are shown enclosed in a polygon. A similar polygon enclosing the prairie dog complex at Meeteetse shows that prairie dogs occupy about 22% of the area within the polygon. If nearby colonies are sufficiently large they could be incorporated with areas of larger concentrations, as shown by the dashed line.

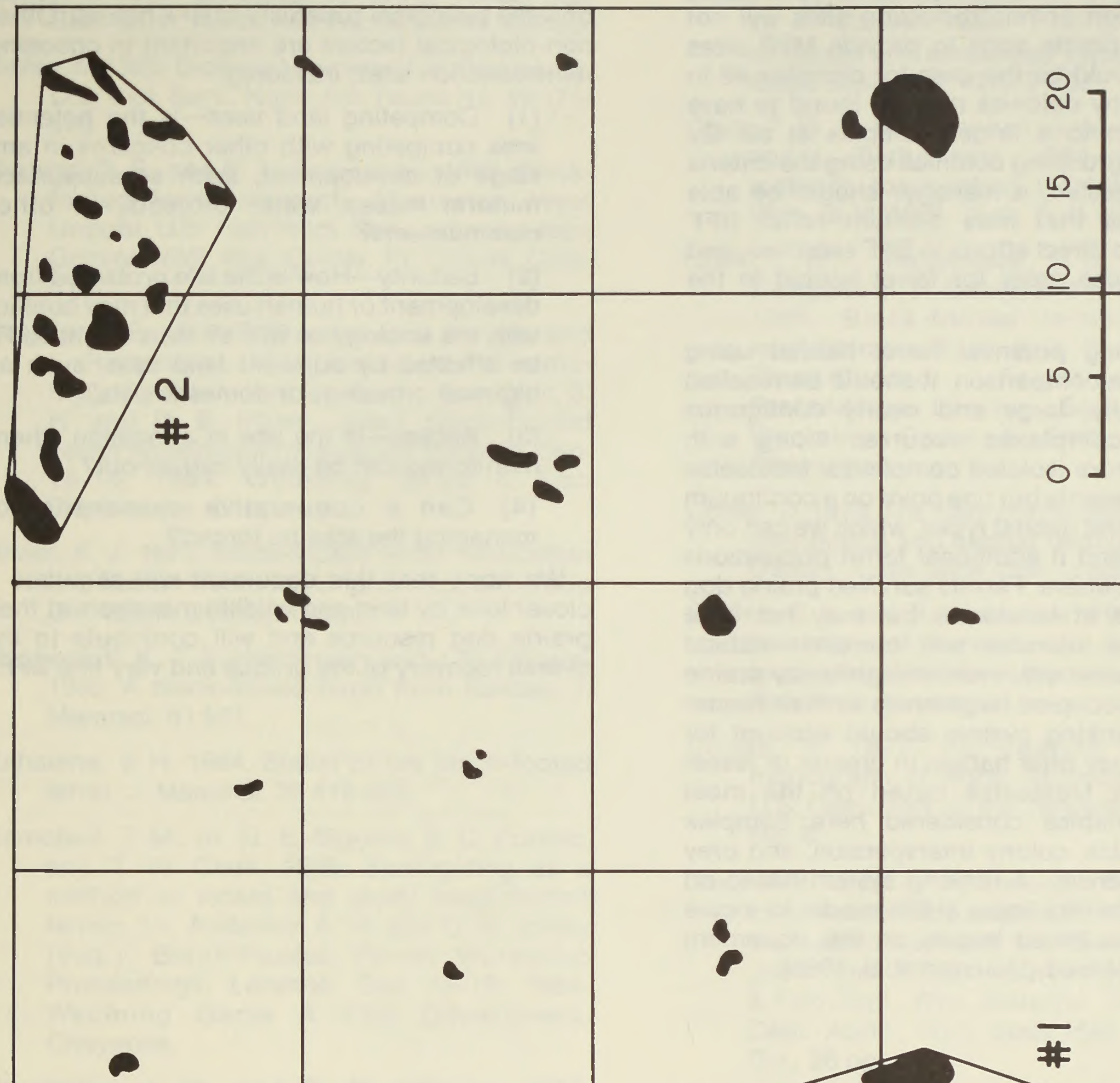

Figure 12. Example of a hypothetical prairie dog complex designation which might support a ferret population.

We expect that many areas initially considered for translocation or reintroduction sites will not have enough prairie dogs to provide MVP sizes for BFF, as would be the case for complex #2 in Figure 12. Many colonies may be found to have no association to a larger complex at all. By selecting and grouping colonies using the criteria we have suggested, a manager should be able to rank areas that may contain relict BFF populations, to direct efforts in BFF searches, and to manage those areas for ferret habitat in the future.

When ranking potential ferret habitat using Meeteetse as a comparison, it should be recalled that historically, large and nearly contiguous prairie dog complexes occurred along with smaller and more isolated complexes. Meeteetse therefore represents but one point on a continuum of potential ferret habitat types, which we can only assess when and if additional ferret populations are found elsewhere. Ferrets survived prairie dog control efforts at Meeteetse but may not have survived more intensive and complete habitat eradication elsewhere, even though today prairie dogs have reoccupied large areas in their former range. The ranking system should account for areas which may offer habitat in greater or lesser qualities than Meeteetse based on the most important variables considered here: complex size, colony size, colony interspersion, and prey (or burrow) density. A ranking system based on a Habitat Suitability Index (HSI) model to locate transplant sites based largely on this document has been developed (Houston et al. 1985).

Finally, this discussion has centered around only the biological suitability of BFF habitat. Other non-biological factors are important in choosing reintroduction sites, including:

(1) Competing land uses—Is the potential area competing with other concerns in any stage of development, such as subsurface mineral leases, water projects, or other commitments?

(2) Security—How is the site protected from development or human uses that may conflict with the ecology of BFF's? How might BFFs be affected by adjacent land uses, such as highway crossings or domestic pets?

(3) Access—Is the site in a location where monitoring can be easily carried out?

(4) Can a cooperative consensus for managing the area be forged?

We hope that this document will stimulate a closer look by land and wildlife managers at their prairie dog resource and will contribute to the overall recovery of the unique and very fine BFF.

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APPENDIX I

Clark, T. W., R. S. Hoffmann, and C. F. Nadler. 1971. *Cynomys leucurus.* Mammalian Species No. 7. 4 pp.

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MAMMALIAN SPECIES No. 7, pp. 1–4, 2 figs.

Cynomys leucurus.

By Tim W. Clark, Robert S. Hoffmann, and Charles F. Nadler

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Cynomys Rafinesque, 1817

Cynomys Rafinesque, 1817:45. Type species *Cynomys socialis* Rafinesque [= *Cynomys ludovicianus*], by original designation.

CONTEXT AND CONTENT. Order Rodentia, Suborder Sciuromorpha, Family Sciuridae. *Cynomys* contains five living species in two subgenera (following key adapted from Hollister, 1916:12).

1 Tail tipped with black .... (*Cynomys*) 2
Tail tipped with and bordered with white .... (*Leucocrossuromys*) 3
2 (1) Black on tail covering most of distal half; posterior border of inflected angle of mandible nearly at right angle to axis of jaw .... *C. mexicanus*
Black on tail confined to distal third; posterior border of inflected angle of mandible at angle of about 45° to axis of jaw .... *C. ludovicianus*
3 (1) Terminal half of tail with gray center, bordered and tipped with white .... *C. gunnisoni*
Terminal half of tail white, without dark center 4
4 (3) Color in summer reddish or rich cinnamon (not buffy or grayish); skull with interorbital breadth more than 13.5 mm. .... *C. parvidens*
Color in summer buffy or grayish; skull with interorbital breadth less than 13.5 mm. .... *C. leucurus*

Cynomys leucurus Merriam, 1890

Cynomys leucurus Merriam, 1890:33. Type locality "Ft. Bridger, Wyoming."

CONTEXT AND CONTENT. Context noted in generic summary above. The species *C. leucurus* is not divided into subspecies (Hollister, 1916).

DIAGNOSIS. The white-tailed prairie dog is the largest member of its subgenus (total length 340 to 370 mm.), and is only slightly smaller than *C. ludovicianus* and *C. mexicanus*, but has a much shorter tail (40 to 65 mm. rather than 82 to 110 mm.). The general color of upper body parts is yellowish buff, streaked with blackish. A spot above the eye and a large area on the cheek are blackish brown. The tail is white; hairs of the proximal half have bands of blackish interspersed with pale cinnamon, whereas those of the distal half are clear white.

GENERAL CHARACTERS. Measurements (in millimeters) are: total length 340 to 370; length of tail 40 to 65; length of hind foot 60 to 65; condylobasal length 56.0 to 61.3; zygomatic breadth 41.7 to 45.4; mastoid breadth 27.4 to 30.0; length of nasal 20.7 to 23.1; length of mandible 41.6 to 44.9; alveolar length of maxillary toothrow 15.1 to 16.0 (modified from Hall and Kelson, 1959, and Hollister, 1916). More detailed descriptions are presented by Hollister (1916), Hall and Kelson (1959) and Long (1965). The skull is illustrated in Figure 1.

DISTRIBUTION. This species is found in parts of Colorado, Utah, Wyoming, and Montana (Figure 2). More specifically, it occurs from the Bighorn Basin, in southern Montana, south across central and southwestern Wyoming into western Colorado and northeastern Utah; east to the Laramie Mountains in Wyoming, and into North Park, Colorado; south into the lower Gunnison Valley; west a few miles across the Bear River Divide into extreme northern Utah, and farther south, into the Green River Valley (Hollister, 1916; Hall and Kelson, 1959; Long, 1965; Durrant, 1952; Warren, 1942; Hoffmann *et al.*, 1969; Lechleitner, 1969). The local distributional pattern, particularly in the southern part of the range, is imperfectly known, owing in part to extirpation of the species in some areas.

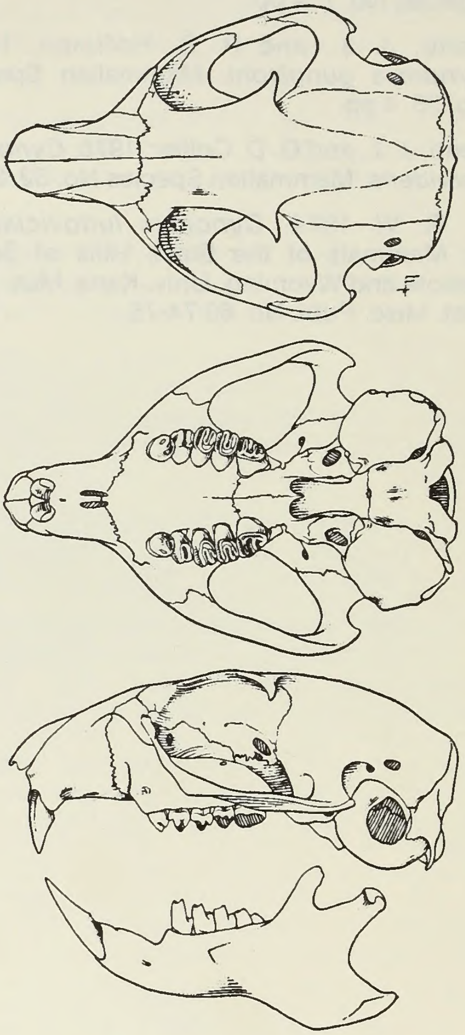

FIGURE 1. Views of skull of *Cynomys leucurus* (Univ. Kansas no. 16802, from Hall and Kelson, 1959:367, by permission of Ronald Press, Inc., New York). From top to bottom, dorsal, ventral, and lateral views of cranium and lateral view of dentary. All × 1.

FOSSIL RECORD. According to Black (1963:226), "we do not yet have unequivocal evidence of the existence of *Cynomys* prior to the Pleistocene." However, several Pleistocene prairie dogs have been described. Hay (1921) based *C. niobrarius* on a palate from the "Sheridan beds" in Nebraska, probably equivalent in age to the Loveland formation, late Pleistocene. Green (1960) named and described *C. spispiza* from a mandible collected in Tripp County, South Dakota, from the Sand Hills formation, and later suggested that it might prove to be synonymous with *C. niobrarius* (see Green, 1963); Green (1960:546) claimed that "*C. spispiza* combines characteristics of both *C. ludovicianus* and *C. leucurus* but is closer to the latter species." The late Pleistocene date does not, however, permit the speculation that *spispiza* might be ancestral to both modern species, as Green originally suggested. Black (*op. cit.*) thought *spispiza* not separable from *C. leucurus*. Dalquest (1967), however, thought that *niobrarius* and *spispiza* were black-tailed prairie dogs, referable to the subgenus *Cynomys*.

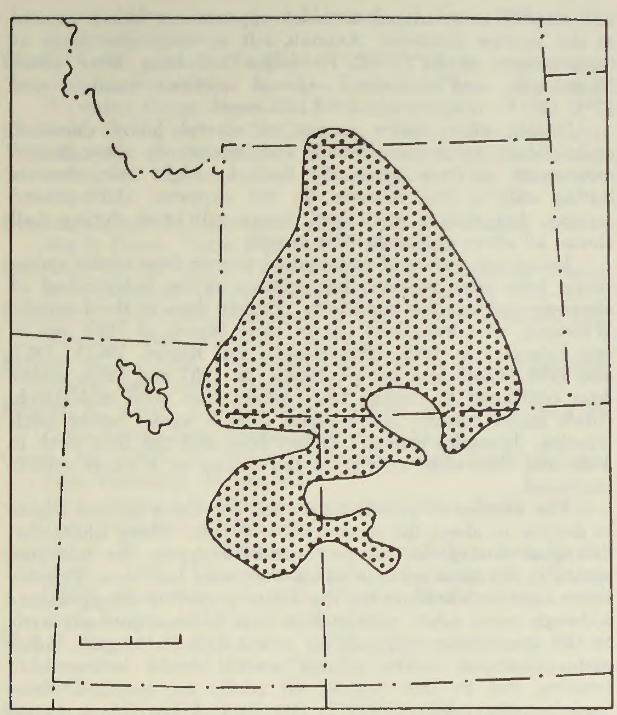

FIGURE 2. Distribution of *Cynomys leucurus* modified after Hall and Kelson (1959:368). The scale at lower left is 100 miles long.

A series of faunas from Meade County in southwestern Kansas span much of the Pleistocene record; the earliest prairie dog appears to be *C. meadensis*, described by Hibbard (1956) from the Deer Park fauna of the early Pleistocene (Aftonian). This animal was about the size of *C. leucurus*, but its cheekteeth were not so high-crowned. From the following glacial period (Kansan), *Cynomys ludovicianus* is identified, and in the Illinoian it was joined by *C. vetus* (Hibbard, 1942), a fossil species even smaller than *gunnisoni*. Hibbard placed *C. vetus* in the subgenus *Cynomys*, but Gromov *et al.* (1965) assigned *vetus* to the subgenus *Leucocrossuromys*. Dalquest (1967) thought that the specimens of *Cynomys* cf. *gunnisoni* reported by Semken (1966) from deposits of Illinoian age in northwestern Kansas were best referred to *C. vetus*, and that "*Cynomys vetus* may be the direct ancestor of *Cynomys gunnisoni* and its related forms." Both *ludovicianus* and *vetus-gunnisoni* were still present in the Sangamon interglacial, but by the Wisconsin, only *ludovicianus* remained. Remains of black-tailed prairie dogs from the Wisconsin are widespread on the Great Plains. During the full-glacial conditions of the Wisconsin period, 25,000 to 40,000 BP (before present), *C. ludovicianus* also occurred in central Texas (Slaughter and Ritchie, 1963). It evidently had a more southerly distribution than at present. The related *C. mexicanus* has a relict distribution in northern Mexico. The relatively few reports of *C. gunnisoni* or *C. leucurus* from the Wisconsin may be due to the scarcity of fossil deposits in areas and habitats occupied by these prairie dogs. Specimens of the former, of uncertain Pleistocene-Recent age, were found in the Isleta Caves, northern New Mexico (Harris and Findley, 1964). The latter species is apparently unreported in the Pleistocene, save as it may be represented by *C. spispiza*, or by specimens now listed as *Cynomys* sp. from near or within the present range of *C. leucurus* (Anderson, 1968). The record supports the generally held contention that "prairie dogs did not branch off from the spermophile line before the later Pliocene" (Black, 1963).

FORM. Gross anatomy was studied by Keener (1930). Hollister (1916:25–26) described molting in *C. leucurus* from Wyoming as follows: "Specimens taken before May 10 are still in the old winter coat, with little evidence of molt. Skins collected from May 20 to June 1 have renewed [the pelage] over most of the underparts and somewhat on the head and shoulders. Numerous examples taken from June 1 to 10 are all in fresh coat except on the lower rump and tail. Skins collected July 15 to 30 are in full summer coat. By August 10 there is much evidence of wear over the forward half of the body, and by early September the fall renewal has commenced. As in the case of *C. ludovicianus*, this progresses forward, and by September 25 to October 1 is complete."

FUNCTION. Electrophoretic patterns of blood sera have not previously been reported. Albumins of *C. leucurus* and *C. gunnisoni* migrate more rapidly than do those of *C. ludovicianus*. Five transferrin bands were observed among *C. leucurus*, *C. gunnisoni*, and *C. ludovicianus*; *C. leucurus* from Wyoming is characterized by the slowest pair of bands (Tf 5,5), which do not occur in the other two species. Work in progress by J. J. Pizzimenti confirms that *C. leucurus* from other localities show similar transferrin band patterns.

ONTOGENY AND REPRODUCTION. Some gross morphological changes in gonads were reported by Stockard (1929, 1934) and Tileston and Lechleitner (1966), and histological changes were described by Bakko and Brown (1967). Copulation occurs in late March and early April at which time the accessory sex glands exhibit peak activity and the testes are regressing from their peak development of a week or so earlier (Bakko and Brown, 1967). Gestation requires about 30 days (Stockard, 1934; Bakko and Brown, 1967) and parturition occurs in late April or early May. The mean litter size from embryo counts ($N = 25$) is 5.64 ± 0.74 S.D. (range 3 to 8); corpora lutea counts ($N = 48$) average 5.40 ± 0.72; and placental scars ($N = 20$) average 4.90 ± 0.77 (Bakko and Brown, 1967). One litter is produced annually. Nothing is known of the growth and development of young prior to their first appearance above-ground in late May or early June.

ECOLOGY. The ecological roles of prairie dogs in general (including *C. leucurus*) were reviewed by Clark (1968). Because of their presumed "direct competition" with livestock, prairie dogs have for about 100 years been subject to continuous disturbance and killing by federal, state, and private interests (Cottam and Caroline, 1965). Prairie dogs have been regarded as "pests" since the settlers began intensive use of the Great Plains, deserts, and intermountain grassland for grazing and agriculture. Wholesale slaughter of natural predators of prairie dogs (badgers, coyotes, bobcats, weasels, and raptors) has accompanied this intensive use.

Bond (1945), Taylor and Davis (1947), Osborn and Allen (1949), and Norris (1950) indicated that prairie dogs tend to be most numerous on range depleted by livestock overgrazing. These investigators concluded that large populations of prairie dogs are more often an effect of range deterioration rather than its cause, and may be symptomatic of poor range condition (Fichter, 1953). It is commonly believed that prairie dogs cause range deterioration, but according to Bond (1945) under certain conditions prairie dogs actually accelerate recovery of deteriorated ranges. Rodents feed mainly on annual forbs and other plants typical of early stages of succession (overgrazed range) and as a result favor the increase of climax plant species, principally good forage grasses. Clements and Clements (1940) have shown that when forbs are present they are preferred by prairie dogs over grass as forage. Koford (1958) stated that if man does not alter the grassland, it is improbable that prairie dogs alone will reduce the range vegetation below the stage where short grasses are dominant. Although most of the ecological studies cited above were based on *C. ludovicianus*, the general conclusions seem valid for *C. leucurus* also.

Revegetation patterns of burrow mounds were investigated by Clark (1970) and range relationships by Clark and Kinker (1970). Mean density of burrow openings varies from 59.1 per hectare (= 23.9 per acre, Clark, 1969) to 54.1 per hectare (= 21.9 per acre, Tileston and Lechleitner, 1966). Prairie dog density averages 3.2 per hectare, range 0.7 to 6.2 (= 1.3 per acre, range 0.3 to 2.5). Maximum densities coincide with the initial appearance of pups above-ground and are as high as 8.4 per hectare (= 3.4 per acre, Tileston and Lechleitner, 1966).

Immigration occurs chiefly in early spring (March and April). In one colony in Wyoming, 12 new animals took up residence one spring and three the next (Clark, 1969). Tileston and Lechleitner (1966) found that immigration played a relatively important role in a town in northern Colorado. From the Wyoming colony, two males emigrated to other towns and took up residence. Movements up to 2.7 km. (1.7 miles) have been reported.

No figures on longevity or population turnover are available in the literature. However, Clark (1969) noted an 8.9 % loss of members of one colony between June and October of 1966. Total loss due to mortality and emigration from September 1966 to spring 1967, was 50 % (36 animals) of the population. The major predators, golden eagle and badger, seemed to be only a minor cause of mortality. Tileston and Lechleitner (1966) reported that only 25 % of a population in Colorado was retaken the following year. Of the 24 animals lost, the fate of 75 % was not determined. Plague seems to be a major mortality factor among prairie dogs (Clark, 1969; Lechleitner *et al.*, 1962). Between June and September an 86 % loss was sustained by a colony in Wyoming, presumably from plague.

Home ranges of juveniles are generally larger than those of adults. The mean of maximum measured lengths of home ranges for adults is 106 m. (347 ft.) or about 90 % of that of the mean of 116 m. (380 ft.) for juveniles. Mean home range size for adults is 5.9 hectares (2.4 acres) or 86 % of that of the mean for juveniles of 6.9 h. (2.8 acres) (Clark, 1969). Home ranges are more or less similar in size from year to year, but the position of the home range of an individual is not always the same. Sometimes home ranges of individuals overlap, and sometimes the home range size of a juvenile is reduced the following year when it is an adult. A few juveniles move to the periphery of the colony to establish their adult home ranges.

BEHAVIOR. Some aspects of behavior were studied by Tileston and Lechleitner (1966). Waring (1970) recorded sounds produced by white-tailed prairie dogs. He noted that these sounds are similar to those produced by *C. gunnisoni*, although sufficiently distinct for species identification. Lechleitner (1969), also reported differences. Erpino (1968) described copulatory behavior of *C. leucurus.* White-tailed prairie dogs do not have a system of social organization similar to that seen in the black-tailed prairie dog (King, 1955; Smith, 1958). The only functional social unit is a transitory one involving the lactating female and her dependent young. Tactile social interactions include sexual and agonistic behavior, "play" (between young and rarely between young and adults), and "kissing" (naso-nasal contact). Mutual grooming and group cooperation in burrow construction has not been reported in *C. leucurus.* Vocal stimuli (sounds) and visual stimuli, to some degree, do coordinate and unify the behavior of the colony.

Clark and Brown (1968) and Tileston and Lechleitner (1966) have described daily and seasonal activity patterns. The general pattern for a colony in Wyoming at an elevation of 2195 m. (7200 ft.) was as follows. Prairie dogs were never observed before sunrise or after sunset. The exact time of emergence each morning varied with the season, being earliest in mid-summer. After emerging from its burrow sometime after sunrise, the prairie dog sits or stands in or near the burrow, looks around for a few minutes, and then proceeds to forage near the burrow, moving farther away as the day progresses. In the hot summer months (June through August) the prairie dog returns to its burrow by mid-morning and usually remains there during the high mid-day temperatures. In late afternoon the prairie dog again emerges from its burrow and begins foraging, but before sunset it retires to its burrow for the night.

Daily mid-summer activity (from late May to early August) thus tends to be bimodal, with activity periods in summer occurring between sunrise and the hours 0900 to 1000, when the temperature begins to rise, and from about 1500, when the temperature begins to drop, until before sunset. In contrast, early and late in the season (from February to April and September to November), daily activity is characterized by unimodal curves peaking usually in the early afternoon.

Generally, not all adults are active above ground at the same time, even in favorable weather. Within a colony there is some activity throughout the day except when weather conditions (such as heavy rain, hail, or high temperature) discourage above-ground activities. Daily activity is not restricted by wind until velocities near 65 to 80 kph (40 to 50 mph) are reached, above which there is an obvious decline in activity. At wind velocities of 90 to 95 kpm (55 to 60 mph) prairie dogs remain near their burrows and activity consists mainly of sitting in or near the burrow.

Temperature is an important regulator of activity. Activity mostly takes place within the range of –10° to +20°C (15° to 70°F). At temperatures of 24° to 27°C (75° to 80°F) animals are active for short periods of time (10 to 15 minutes), but activity is restricted to brief appearances above ground at the burrow entrance. Animals left in open wire traps at temperatures of 24°C (75°F) begin salivating after about 30 minutes, and die when exposed to direct sunlight and 27°C (80°F) temperatures for 2 to 3 hours.

During heavy snow storms of several hours duration, prairie dogs go below ground, and afterwards above-ground movements in fresh snow are limited. Light rain showers lasting only a few minutes do not suppress above-ground activity, but during prolonged heavy rain and during hail storms all above-ground activity ceases.

Initial emergence of white-tailed prairie dogs in the spring varies from year to year, but appears to be independent of above-ground weather conditions. Prairie dogs in the Laramie, Wyoming, area were first out in early March of 1964 and in late February in 1965, 1966 (Bakko and Brown, 1967), 1967, and 1968 (Clark and Brown, 1968). In 1967 and 1968, prairie dogs continued to emerge from hibernation until mid-March. Adult males became active about 2 to 3 weeks before adult females. Juveniles emerged in late May and the first week in June and thereafter activity in the colony as a whole greatly increased.

The number of prairie dogs observed above ground begins to decline in about the second week of July. Many adults that disappear during the summer months reappear the following spring in the same areas in which they were last seen. Possibly these animals hibernate for the entire period of disappearance although some adult prairie dogs that become dormant early in the season may reappear for a few days in August. Adult males disappear below ground several weeks before adult females, and by late August, all adults are inactive. Some juveniles begin hibernating in late August, but others do not enter hibernation until late October or early November. There is no apparent difference in time of seasonal disappearance between juvenile males and females.

Animals were active in a Wyoming colony (elevation 2195 m. or 7200 ft.) for a total of about 8½ months (Clark and Brown, 1968), adults for about 5 months (from late February to mid-August) and juveniles for about the same length of time (from June to late October or early November). Tileston and Lechleitner (1966) reported that white-tailed prairie dogs in northern Colorado (elevation 2500 m. or 8200 ft.) were active a total of only 7 months.

GENETICS. The diploid chromosome number in *C. leucurus* is 50; the karyotype contains seven pairs of metacentric chromosomes and 18 pairs of submetacentric or subtelocentric chromosomes. Five females from Wyoming collected by Clark were analyzed by Nadler; sex chromosomes were not therefore identified and are included in the above enumeration. Although both *C. leucurus* and *C. ludovicianus* have a $2N$ of 50, they differ considerably in their complements of metacentric and submetacentric chromosomes, the latter having 15 pairs of metacentric and nine pairs of submetacentric or subtelocentric autosomes (Nadler and Harris, 1967). Work in progress by J. J. Pizzimenti confirms the $2N = 50$ from elsewhere within the range of *C. leucurus.*

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Mammalian Species No. 25, pp. 1–4, 2 figs.

Cynomys gunnisoni. By John J. Pizzimenti and Robert S. Hoffmann

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Cynomys gunnisoni (Baird, 1858)

Gunnison's Prairie Dog

Spermophilus gunnisoni Baird, 1855:334. Type locality "Cochetope Pass" (Cochetopa Pass, Saguache Co., Colorado).
Cynomys gunnisoni: Baird, 1858:xxxix. First use of current name combination.

CONTEXT AND CONTENT. Order Rodentia, Suborder Sciuromorpha, Family Sciuridae, Genus *Cynomys*, Subgenus *Leucocrossuromys*. See Clark *et al.* (1971) for a diagnostic key to the five living species of *Cynomys*. *Cynomys gunnisoni* is divided into two subspecies (Hollister, 1916).

Cynomys gunnisoni gunnisoni (Baird, 1858:xxxix), see above.
Cynomys gunnisoni zuniensis Hollister, 1916:32. Type locality "Wingate, McKinley County, New Mexico."

DIAGNOSIS. Total length of adult Gunnison's prairie dogs varies from 309 to 373 mm and adults weigh 650 to 1200 g; males average larger than females. The species thus is smaller than *C. leucurus*, but slightly larger than *C. parvidens*, the other two species in the subgenus *Leucocrossuromys*. The dorsal color is yellowish buff intermixed with blackish hairs. The top of the head, sides of cheeks, and "eyebrows" are noticeably darker than other parts of the pelage. The species differs from black-tailed prairie dogs (*C. ludovicianus* and *C. mexicanus*, subgenus *Cynomys*) in having a much shorter tail (39 to 68 mm), less than one-fifth the total body length. The proximal half of the tail is the same color as the dorsal pelage; the distal one-half has a grayish center tipped with grayish-white hairs. Tail color usually demarcates *C. gunnisoni* from other white-tailed species, which possess pure white hairs on the distal one-half of the tail (Clark *et al.*, 1971).

GENERAL CHARACTERS. Gunnison's prairie dog is a stout-bodied spermophile-like mammal found in semi-social aggregations (see Ecology and Behavior). The subspecies differ slightly in color and size; *zuniensis* averages slightly larger, has a larger hind foot and heavier skull, and exhibits a paler color (more cinnamon cast and less yellowish buff). Hollister (1916) described the cranial characteristics of *C. gunnisoni* as follows: "Skull smaller than *leucurus*, larger than *parvidens*; differs from both in more broadly spreading maxillary arm of zygoma; mastoids smaller and more obliquely placed, rather than in general occipital plane; auditory bullae smaller; occiput viewed from behind higher and less broadened; inferior rim of angle of ascending branch of jugal averaging less pointed, more rounded with little trace of special lateral flattened surface." Ranges of some measurements in adults (including both subspecies) are (in millimeters, modified from Hall and Kelson, 1959; Durrant, 1952; and Hollister, 1916): total length 309 to 373; length of tail 39 to 68; length of hind foot 52 to 62.5; condylobasal length of skull 51.9 to 59.0; length of nasals 20.0 to 22.4; zygomatic breadth 40.4 to 45.0; interorbital breadth 12.0 to 15.2; mastoid breadth 26.0 to 27.7; palatal length 27.6 to 30.1; and alveolar length of maxillary toothrow 14.0 to 15.6. The skull is illustrated in figure 1. For a more detailed description of morphology see Hollister (1916), Bailey (1931), Durrant (1952), and Lechleitner (1969). Although several physical attributes can be used to distinguish *C. gunnisoni* from other species of prairie dogs, vocalizations, particularly alarm barks, are species-specific and permit identification (see Ecology and Behavior).

DISTRIBUTION. The species is limited to high mountain valleys and plateaus in the southern Rocky Mountains at elevations of 1830 m (6000 ft) to 3660 m (12,000 ft). Its distribution centers around the "Four Corners" region where the states of Utah, Colorado, New Mexico, and Arizona meet (figure 2). *C. g. zuniensis* occurs in parts of all four states, whereas *C. g. gunnisoni* is found only from central Colorado through north-central New Mexico. In many areas distribution is limited by pronounced physiographic barriers. The most northerly populations of *C. g. gunnisoni* are found in South Park, Colorado; from there the range extends southward through the Arkansas River Valley into the San Luis Valley, and westward into the upper Gunnison River drainage where it closely approaches the range of *C. leucurus* in southwestern Gunnison County. It is in this area that suspected hybridization with *C. leucurus* has been reported (Lechleitner, 1969), and is under current investigation by Pizzimenti. South of the San Luis Valley, populations extend to north-central New Mexico where their distribution is partially checked by the Sangre de Cristo, San Juan, and Jemez mountain ranges. It is in this area that "they grade into the lightly marked subspecies *zuniensis*" (Bailey, 1931:126). *C. g. zuniensis* is found in extreme southwestern Colorado and extreme southeastern Utah, where it is separated from *C. leucurus* to the north and east by the

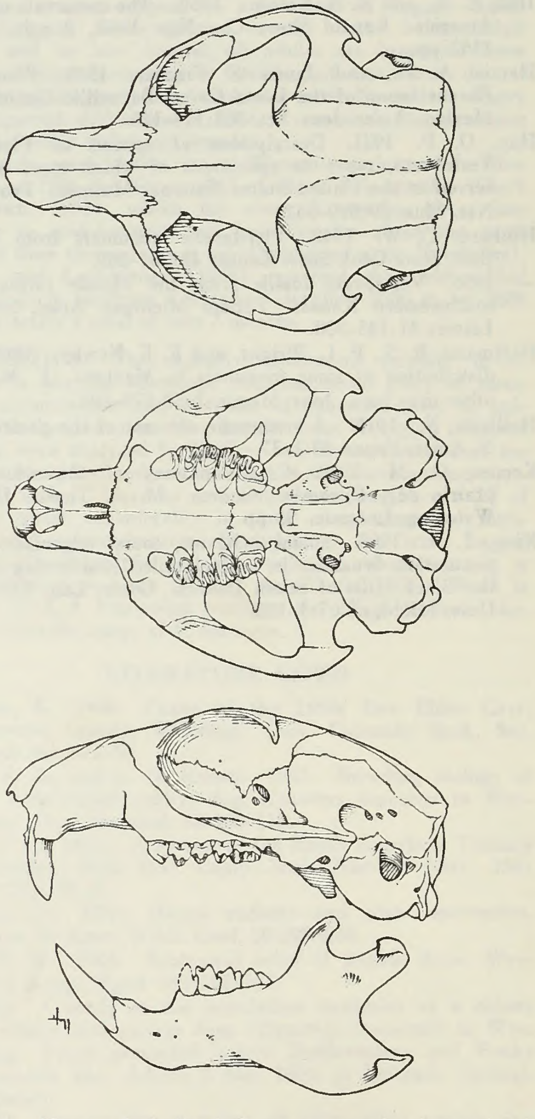

Figure 1. Views of skull of *Cynomys gunnisoni gunnisoni* (Univ. Kansas no. 6236, from Hall and Kelson, 1959:369, by permission of Ronald Press, Inc., New York). From top to bottom, dorsal, ventral, and lateral views of cranium and lateral view of dentary, all × 1.

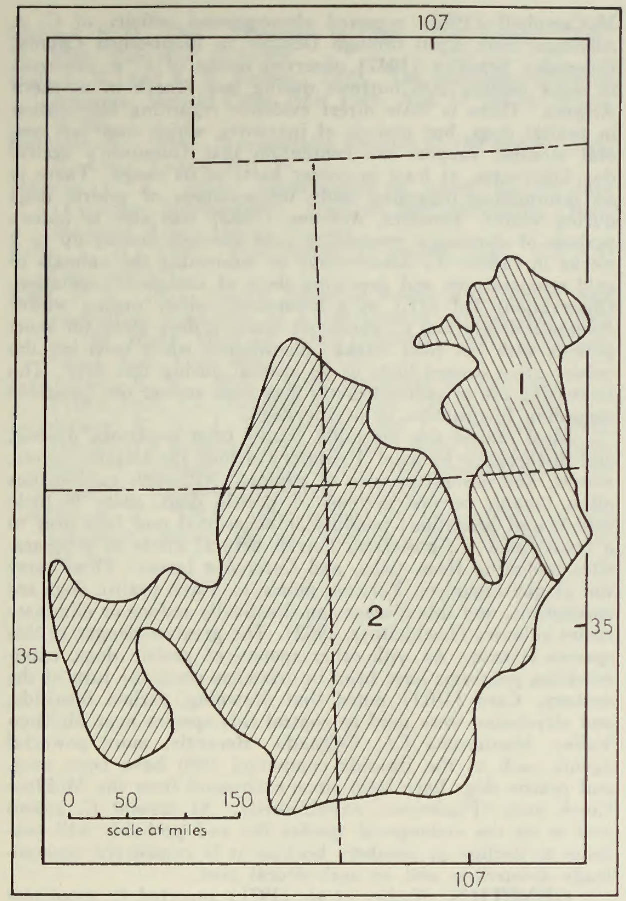

FIGURE 2. Distribution of *Cynomys gunnisoni* (modified after Hall and Kelson, 1959:368), and of the subspecies: 1, *C. g. gunnisoni*; 2. *C. g. zuniensis*.

Uncompaghre Plateau and San Juan Mountains. The range extends to the south and east into the Santa Fe, New Mexico area, and to the Rio Grande Valley near Albuquerque, where they have been taken at the same localities with *C. ludovicianus arizonensis* (Bailey, 1931:127). The southern limit is reached in the Mogollon Mountains in southwestern New Mexico. In Arizona, *C. g. zuniensis* occurs from the "Four Corners" region as far south as Graham County; north of the Gila River and to west-central Arizona in Coconino, Yavapai, and Maricopa counties. Disturbance has greatly reduced numbers and range of prairie dogs in Arizona (Cockrum, 1960) and this is undoubtedly true in other areas as well. For further details of distribution see Cary (1911), Bailey (1931), Warren (1942), Durrant (1952), Cockrum (1960), Lechleitner (1969), and Hall and Kelson (1959).

FOSSIL RECORD. For a discussion of the fossil record of *C. gunnisoni* and other species of the genus *Cynomys*, see Mammalian Species no. 7 (Clark *et al.*, 1971).

FORM. Hollister (1916) described two annual molts, occurring in the spring and again in autumn, except on the tail where only a single annual renewal prevails. Spring molt begins anteriorly and proceeds posteriorly until finally the tail hair is renewed. The tail may retain its winter pelage as late as 10 August at higher altitudes and latitudes. Winter coat renewal proceeds from the posterior part of the body anteriorly. Molt is usually complete by 15 September and mid-October specimens have a long full coat with dense underfur. Molt patterns are more pronounced in the warmer parts of the range, whereas autumn renewal in colder areas is more subtle due to the short summer season and slight wear on summer pelage. Hollister (1916) mentioned partly and totally melanistic individuals of *C. gunnisoni* in South Park, but did not himself examine any.

Gunnison's prairie dog has five pairs of mammae (two pectoral, three inguinal) as do other members of the subgenus (Longhurst, 1944; Moore, 1961); members of the subgenus *Cynomys* possess only four pairs. Hollister (1916) claimed that in *Leucocrossuromys* six pairs of mammae occurred rarely, but did not provide details.

Burt (1960) compared bacular morphology of several prairie dogs. The bacula of two specimens, one of *gunnisoni* and one of *leucurus*, were similar, but both were easily distinguished from bacula of *C. ludovicianus*. Bryant (1945) examined bacula from *C. gunnisoni* and *C. mexicanus*. Both authors noted the resemblance between bacula of *Cynomys* and those of ground squirrels (genus *Spermophilus*).

Bryant (1945) noted that within the genus *Cynomys* the masticatory muscles are, proportionally, the stoutest and most highly developed among the Nearctic Sciuridae, and that the crown height of cheekteeth equals or exceeds that of all other Nearctic Sciuridae; these characteristics reflect the adaptation of prairie dogs to a graminivorous diet.

FUNCTION. Nadler *et al.* (1971) reported on electrophoretic mobilities of some serum proteins. Albumins of *C. gunnisoni* showed no differences from those of *C. leucurus* and *C. parvidens*, but differed from slower albumins of *C. ludovicianus*. Serum transferrins were unique among all species of prairie dogs. Transferrin mobilities were designated 1 to 5 in order of fastest to slowest mobility. *C. gunnisoni* was monomorphic (homozygous) for Tf 4; *C. leucurus* for Tf 5; whereas *C. ludovicianus* was polymorphic, exhibiting homozygous and heterozygous states for three fast moving bands (Tf 1, 2, and 3) with a maximum of two bands per individual (Tf 1-2, 2-2, 2-3).

ONTOGENY AND REPRODUCTION. Onset of reproduction is somewhat variable and is dependent on latitude, elevation, and seasonal variation (Aldous, 1935; Longhurst, 1944; Scheffer, 1947). Females bear a single litter per year and are capable of reproducing at 1 year of age (Longhurst, 1944). Gestation lasts approximately 30 days. Scheffer (1947) examined nine pregnant *C. g. zuniensis* females in northern Arizona and estimated that parturition would occur in April or early May. Females were lactating in mid-May and pups were above ground by 3 June at elevations of 2135 to 2590 m (7000–8500 ft). Aldous (1935) found that 27 of 29 females examined were pregnant, most in advanced stages, on 17 April at Norwood, Montrose Co., Colorado, 2135 m (7000 ft). Longhurst (1944) reported the first emergence of *C. g. gunnisoni* pups for several elevations in Costilla County, Colorado as: 27 June at 2590 m (8500 ft); 1 July at 2680 m (8800 ft); 14 July at 2800 m (9200 ft); and 16 July at 2900 m (9500 ft). A female from Cochetopa Pass, 2800 m, contained three near-term embryos (38 mm in crown-rump length) on 3 June (Pizzimenti, unpublished).

Gunnison's prairie dog has smaller litters than the white-tailed prairie dog (*C. leucurus*), in which mean embryo counts are about 5.5 (Stockard, 1929; Clark *et al.*, 1971). Scheffer (1947) reported a modal litter size of three for *C. g. zuniensis* in Arizona based on observations of emerging pups. In the 27 pregnancies examined by Aldous (*op. cit.*), mean embryo count was 4.78 (range, 1 to 7); the modal number was four. Two specimens from Flagstaff, Arizona, 2135 m (7000 ft), had four and three uterine scars respectively; one female from Dolores Pass, Colorado, 3050 m (10,000 ft), contained three embryos near term on 9 May. Longhurst (1944) examined 55 *C. g. gunnisoni* females from Costilla County, Colorado; 12 yearlings and 34 adults were pregnant and averaged 4.1 and 4.9 uterine scars, respectively. Eight of the 20 yearlings were nulliparous, whereas only one of 35 adults failed to breed that season. Thus, although *gunnisoni* females are capable of reproduction when near 1 year of age, fewer yearlings produce young than do adults 2 years of age or older, and those that do have smaller litters.

Young remain underground for about a month. Nothing is known about growth and development during this period; however, growth and development have been described for *C. ludovicianus* (Johnson, 1927) and probably are similar for *C. gunnisoni*. Nursing may continue for a short period after emergence but the young are soon independent and feeding on vegetation. As soon as the young are weaned, the female abandons them at the nesting burrow and establishes herself at another burrow; shortly thereafter the young disperse to other unoccupied burrows.

ECOLOGY AND BEHAVIOR. There have been few intensive ecological studies of *C. gunnisoni* and much of what follows is from Longhurst (1944), Scheffer (1947), and personal field observations (JJP). Colonies of *C. gunnisoni* are generally smaller than those of other species of prairie dogs, often consisting of fewer than 50 to 100 individuals. Social organization is loosely knit and more closely resembles that of ground squirrel aggregations than it does the more highly structured organization of *C. ludovicianus* (see King, 1955). Compared to black-tailed prairie dog habitat, the habitat of *C. gunnisoni* is topographically and vegetationally highly variable, and as a consequence, visual contacts between individuals of an aggregation are sometimes obstructed. Where habitat is open and the animals have been afforded protection (for example, at Blue Mesa Reservoir, Gunnison County, Colorado) colonies can become extensive and densely populated. However suitable areas are more often small and patchy, resulting in more spermophile-like living habits.

Territoriality is not pronounced in *C. gunnisoni*; old males may defend a small area near their burrows but often feed alongside other members of the colony. Social structure consists mainly of mother-offspring relationships. Longhurst (1944) noted that adult males were living somewhat apart from females and offspring in June and this tendency increased throughout the summer. Yearling males lived closer to females. In *C. ludovicianus*, females are highly territorial and aggressive during the post-natal period. However, as soon as the pups emerge above ground, aggressive behavior subsides and they soon resume normal social interactions (King, 1955). Female Richardson's ground squirrels (*Spermophilus richardsonii*) show similar aggressiveness and territoriality during the reproductive season (Clark, 1970; Clark and Denniston, 1970). It seems likely that Longhurst's (*op. cit.*) observations result from territorial behavior in female *C. gunnisoni* even though there are no reports of agonistic behavior or territorial disputes.

Waring (1970) studied sound communication in prairie dogs. The alarm call of *C. gunnisoni* differs from those of other species of prairie dogs, and is important to the cohesion and survival of a colony. The call consists of a series of high pitched barks of one or two distinct syllables, which may be frequently repeated for as long as one-half hour. The second syllable is more gutteral, being equal or lower in pitch than the first, and may be formed by inhalation. Frequency of repetition and intensity increases as danger becomes more imminent, culminating in a chatter as the animal disappears down its burrow.

The burrow systems and mounds are more similar to those of ground squirrels than are those of other species of prairie dogs. Dirt is loosened and scraped with the forefeet and haphazardly kicked out of the entrance with the hind feet. As a result, a mound of subsoil accumulates at the entrance, but no effort is made to modify the mound. Entrances are usually situated on slopes or small hummocks rather than in depressions, which protects the burrows from flooding. The few burrow systems that have been excavated indicate that they are shallower than those of *C. ludovicianus*. Longhurst (1944) illustrated four systems; depth averaged 840, 740, 1400, and 2030 mm. In general, older systems are deeper, have more entrances at the surface, and more bifurcations below. Old tunnels are sometimes plugged. Usually a single nest consisting of dried vegetation is constructed. There is no evidence that prairie dogs store food in their burrows. Few scats are found in the burrows, defecation occurring on the surface near the mound or at feeding sites. Scheffer (1947) reported similar findings for *C. g. zuniensis* in Arizona.

Prairie dogs are strictly diurnal and are not seen above ground when the sun is below the horizon. Greatest activity occurs in the early morning and late afternoon. Dogs tend to remain in the burrows during inclement weather and midday heat. Above-ground activities are mostly concerned with feeding and to some extent playing and grooming. There is a constant vigilance for possible danger, and while above ground, prairie dogs continually sit up on their hind feet to survey their surroundings; mounds are often used as sentinel posts. Their eyes, positioned on the sides of the head, are adapted for detecting movement from a wide arc.

Analysis of stomach contents from 157 *C. g. gunnisoni* was reported by Longhurst (1944). In general, grasses are the most important food item with forbs, sedges, and shrubs of lesser importance. Smith (1915), Burnett and McCampbell (1926), Stockard (1929), and Kelso (1939), reported grasshoppers, beetles, and cutworms in the prairie dog diet but these are of minor importance.

Winter is a period of inactivity for *C. gunnisoni* in most localities. Higher elevations may have several feet of snow for long periods of time. The dogs undoubtedly remain underground, using as an energy supply stored fat that has been accumulated over the summer. Emergence probably occurs in early spring depending on latitude and elevation. Burnett and McCampbell (1926) reported above-ground activity of *C. g. zuniensis* from April through October in Montezuma County, Colorado; Scheffer (1947) observed tracks of *C. g. zuniensis* in snow leading into burrows during late March in northern Arizona. There is little direct evidence regarding hibernation in prairie dogs, but periods of inactivity, which may last several months, support the contention that Gunnison's prairie dog hibernates, at least in colder parts of its range. There is no information regarding body temperatures of prairie dogs during winter. However, Anthony (1953) was able to induce periods of dormancy resembling cold narcosis lasting up to 2 weeks in captive *C. ludovicianus* by subjecting the animals to cold temperatures and depriving them of succulent vegetation. Observations (of JJP) of a laboratory colony during winter months indicate that *C. gunnisoni* enters a deep sleep for short periods with low food intake; disturbance while servicing the colony often caused little or no arousal during this time. The increasing use of radiotelemetry may soon answer the questions regarding hibernation in prairie dogs.

Most prairie dog mortality results from predators, disease, and disturbance by man. Predators include the badger, coyote, weasel, and several species of raptors. Although rattlesnakes often inhabit burrow systems of prairie dogs, there is little evidence of predation; possibly an occasional pup falls prey to a rattlesnake. *C. gunnisoni* carries several kinds of ectoparasites including fleas, ticks, and *Cuterebra* larvae. Fleas carry the plague organism, *Yersinia pestis*, to which prairie dogs are susceptible, and this disease can drastically reduce or eliminate entire colonies (Lechleitner, 1962). The greatest danger to this species is man. As with other species of prairie dogs, extermination programs have been in existence since the turn of the century. Cary (1911) noted that drowning, carbon bisulfide, and strychnine were used to control this species near McElmo Valley, Montezuma Co., Colorado. Recently, more powerful agents such as the fluoride compound 1080 have been used, and prairie dogs have been since extirpated from the McElmo Creek area (Pizzimenti, unpublished). At present *C. gunnisoni* is on the endangered species list and probably will continue to decline in numbers because it is considered economically deleterious and an agricultural pest.

GENETICS. Nadler *et al.* (1971) reported *C. gunnisoni* to have a diploid number of 40. The karyotype consists of six pairs of metacentric, eight pairs of submetacentric, and five pairs of subtelocentric autosomes; the X and Y chromosomes are subtelocentric and submetacentric, respectively. The karyotype is strikingly different from that of all other species of prairie dogs that have been thus far examined, in which $2N = 50$.

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MAMMALIAN SPECIES No. 52, pp. 1–3, 2 figs.

Cynomys parvidens. By John J. Pizzimenti and G. Donald Collier

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Cynomys parvidens (Allen, 1905)

Utah Prairie Dog

Cynomys parvidens Allen, 1905:119. Type locality Buckskin Valley, Iron County, Utah.

CONTEXT AND CONTENT. Order Rodentia, Suborder Sciuromorpha, Family Sciuridae, Genus *Cynomys*, Subgenus *Leucocrossuromys*. See Clark *et al.* (1971) for a diagnostic key to the five living species of *Cynomys*.

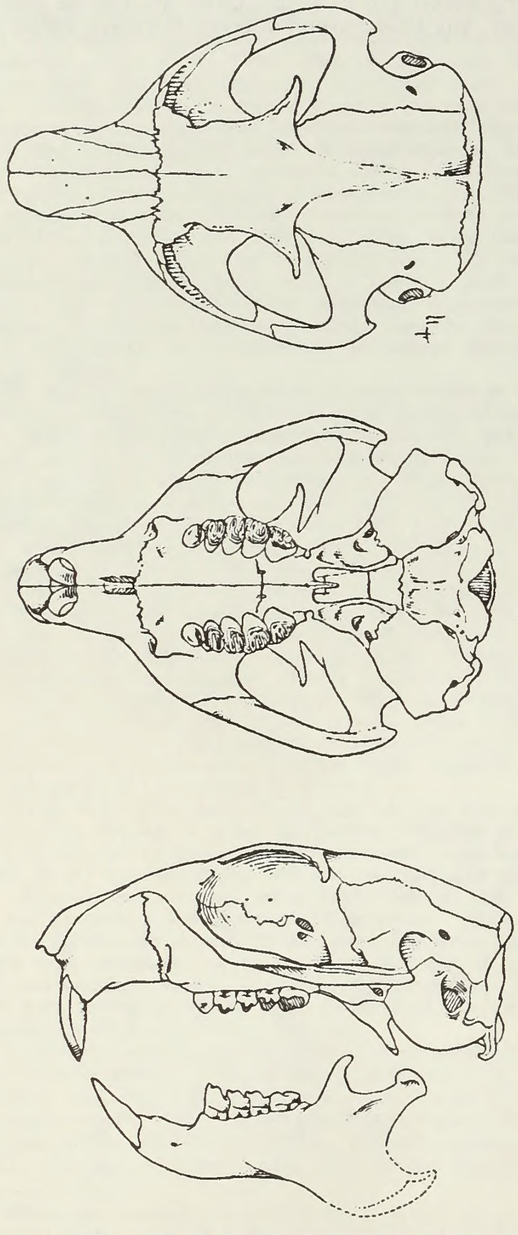

FIGURE 1. Views of skull of *Cynomys parvidens* (Univ. Kansas no. 15962, Cedar City, Utah, from Hall and Kelson, 1959:367, by permission of Ronald Press, Inc., New York). From top to bottom; dorsal, ventral, and lateral views of cranium and lateral view of dentary, all × 1.

DIAGNOSIS. In general, the Utah prairie dog is a small member of the genus. Adult males average 338 (305 to 360) mm in total length. Nothing has been reported on weights, but examination of a few museum specimens indicates weights similar to those in *C. leucurus*, with males probably averaging heavier than females. The relatively short (30 to 57 mm), white-tipped tail designates *C. parvidens* as a member of the subgenus *Leucocrossuromys* and thereby distinguishes it from species of the subgenus *Cynomys*. The dorsum, including the proximal half of the tail, is cinnamon to clay in color, readily distinguishing *C. parvidens* from the more buffy-colored *C. leucurus* and *C. g. gunnisoni*. Although some specimens of *C. gunnisoni zuniensis* resemble *C. parvidens* in dorsal color, the "zunis" are separable by their grayish-centered tails and lack of the sharply outlined black "eyebrows," which are prominent in *C. parvidens*. Durrant (1952) compared skulls of *C. parvidens* to those of *C. g. zuniensis* as: "Larger in almost every measurement taken; interorbital breadth wider; zygomatic arches relatively weaker; nasals longer and narrower posteriorly; posterior ends of nasals rounded rather than truncate; alveolar length of upper molariform series more; teeth smaller relative to size of skull."

GENERAL CHARACTERS. Although *C. parvidens* is relatively small, large individuals may be slightly larger than individuals of *C. g. zuniensis* from Utah (Durrant, 1952). Individual body hairs are multicolored. From base to tip, they are black, pale buff, cinnamon, and finally tipped with dark brown or pale buff. The cheeks are marked by a brown patch, the mouth and chin are whitish, and the underparts are cinnamon to pale buff. Ranges of adult measurements (in millimeters, modified from Hollister, 1916, and Durrant, 1952) are: total length 305 to 360, tail 30 to 60, hind foot 55 to 66, ear 12 to 16, condylobasal length 53.0 to 57.9, length of nasals 20.5 to 23.3, zygomatic breadth 38.3 to 44.7, mandibular length 40.3 to 43.7, mastoid breadth 26.7 to 29.8, and alveolar length of maxillary tooth row 14.8 to 15.5. The skull is illustrated in Figure 1. For a more detailed description of morphology, see Hollister (1916) and Durrant (1952).

DISTRIBUTION. The range of *C. parvidens* is limited to the southern half of Utah (figure 2). Local distribution began fluctuating and diminishing when control programs were initiated early in this century. Prior to control, *C. parvidens* reportedly occurred from the Pine and Buckskin valleys in Beaver and Iron counties (Allen, 1905), as far north as Nephi (Hollister, 1916; Durrant, 1952), south to Bryce Canyon National Park (Presnall, 1938), and east to the foothills of the Aquarius Plateau, where it was recorded as a dominant mammal by Tanner (1940). Hardy (1937), Long (1940), and Stanford (1931) presented additional historical details on the range of this species.

Recent information (Collier, 1974) indicates the species has at one time or another inhabited approximately 700 sections in 10 distinct areas in southern Utah. In the past 50 years there has been an estimated 87% decline in the number of sections occupied. *C. parvidens* now occurs in substantial populations in only three places: the Awapa Plateau, along the East fork of the Sevier River, and in eastern Iron County. In addition, the Grass and Sevier River valleys plus three small, widely separated mountain valleys have small populations. The Aquarius Plateau, Fremont and Paria valleys, and Salina Canyon now have only traces of activity or no prairie dogs.

Reports that prairie dogs occurred at Nephi lack voucher specimens and may be erroneous; local residents there commonly refer to the Uinta (*Spermophilus armatus*) and Townsend's ground squirrels (*S. townsendii*) as prairie dogs. The northernmost verified record is at Salina Canyon in Sevier County, 70 miles south of Nephi. Presently, the northernmost active colony is near Koosharem, Sevier County, 90 miles south of Nephi. Northward expansion is presumably checked by competition with Uinta ground squirrels and/or dense vegetation. There is evidence that *C. parvidens* once occurred through

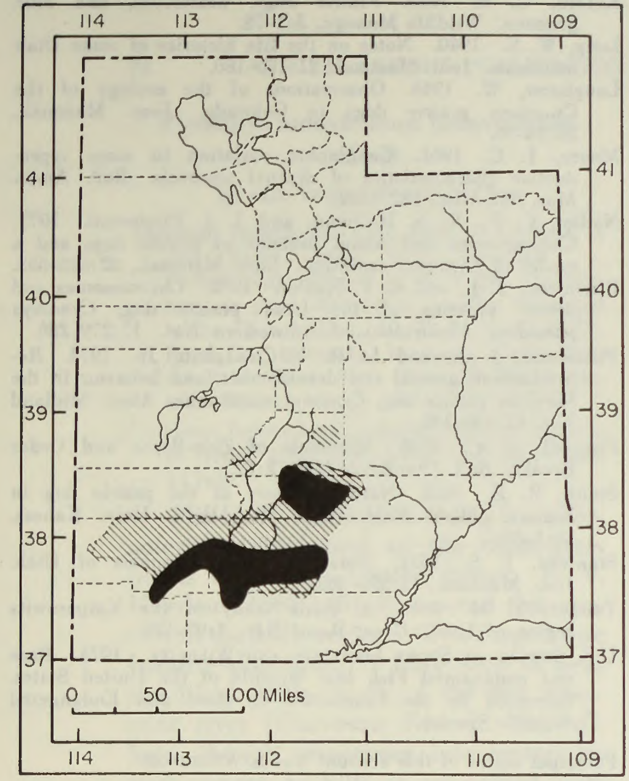

FIGURE 2. Distribution of *Cynomys parvidens.* Diagonal lines represent distribution in 1920; dark area represents distribution in 1970. The southernmost dark projection should be diagonally lined in part.

the Escalante Valley as far west as Modena, Utah, near the Nevada state line but has since been extirpated. Physical barriers and lack of suitable habitat have prevented expansion to the east and south of the present range.

The Utah prairie dog probably inhabited large segments of the Great Basin in post-pluvial times (Collier and Spillett, 1975). With drying climatic conditions, the Great Basin became unsuitable habitat forcing the species to retreat to its recent and more restricted range. This retreat probably became more rapid after shrub invasion and grass decline was accelerated by human settlement and subsequent overgrazing.

As with other species of prairie dogs, poisoning has been the single most important cause of the Utah prairie dog's decline since 1920 although disease has also been considered an important factor by some workers (Fisher *et al.*, 1969).

FOSSIL RECORD. Prairie dog bones excavated from two Fremont village sites near Cedar City, Utah, have been dated between 500 A. D. and 1300 A. D. (personal communication, G. F. Dalley). Prairie dog bones comprised less than 1% of the total number of bones identified at these sites. The Cedar City site is one of five localities at which extant populations of the Utah prairie dog are known. Clark *et al.* (1971) discussed the fossil record of the genus.

FORM AND FUNCTION. The molt pattern in *C. parvidens* has not been described in detail, but it probably consists of two renewals annually. Hollister (1916) remarked on the indistinctiveness of the molt pattern during the transition from summer to winter pelage. Of the few specimens he examined, one was still in full winter pelage on 19 May; by August or September, summer pelage was worn and some individuals already were accumulating a thick winter coat. Specimens collected after late October were in full winter pelage.

C. parvidens possesses five pairs of mammae (two pectoral, three inguinal) as found in other species of white-tailed prairie dogs (Moore, 1961). Hollister (1916) stated that white-tailed prairie dogs occasionally had 12 mammae, but did not elaborate.

Serum protein electrophoresis revealed that the serum albumins of *C. parvidens* were monomorphic throughout the distribution of the species, and identical in mobility to the monomorphic albumins of *C. leucurus* and *C. gunnisoni* (Pizzimenti and Nadler, 1972). The transferrin locus of *C. parvidens* also was monomorphic and identical in mobility to that of *C. leucurus* (Tf-5); this allele had the slowest mobility of all transferrin isozymes reported for the genus (Nadler *et al.*, 1971).

ECOLOGY. Until recently, little information was available on the ecology of the Utah prairie dog. Distribution and ecology are presently under investigation (GDC) and much of what follows stems from personal observations.

Like other species of prairie dogs, *C. parvidens* is colonial and diurnal, and feeds primarily on forbs and grasses. The burrows are similar to those of *C. leucurus* in that they consist of a mound of dirt formed by the haphazard removal of subsoil and do not represent a constructive effort as in the black-tailed species (see Smith, 1958, and King, 1955). A mound may have a single entrance or occasionally two or more entrances that may interconnect; size of the mound and number of entrances increase with the age of the burrow system. Although small mounds with single-entrance burrows are the most common, mounds of old systems may exceed 3 m (10 feet) in diameter, 0.6 m (2 feet) in height, and have 5 or more entrances. The angle of descent into the tunnel varies but, as in *C. leucurus*, usually slopes downward at about 45 degrees. No excavations of *C. parvidens* burrow systems have been reported.

Population densities of colonies are extremely variable, ranging from a mean of less than 2.5 per hectare (one per acre) to more than 74 per hectare (30 per acre). Population density appears to be influenced by condition of the habitat, as observed with other species (Koford, 1958; Longhurst, 1944). Areas with lush vegetation, provided the vegetation is not too tall, tend to support higher densities.

Reproduction occurs once annually, in the early spring. This contention is supported by the abundance of juveniles observed in the early summer, as well as laboratory observation of the reproductively quiescent state of males except during late winter and early spring. This pattern appears to be consistent throughout the genus, with the exception of *C. mexicanus* (Pizzimenti and McClenaghan, 1974). Litter size for *C. parvidens* resembles that of other members of the genus. Four captive pregnant females delivered an average of 4.8 young (range 3 to 6); all of the pups were born between 10 and 16 April. Reproduction may, however, be delayed 2 to 4 weeks at higher elevations, as also occurs in *C. gunnisoni* (Longhurst, 1944).

Poisoning programs have effectively reduced the number of colonies and individuals of *C. parvidens*, although since 1963 poisoning has been conducted solely by private individuals on private lands. In 1971, poisoning annihilated one of the few remaining large colonies (near Loa, Wayne County). In 1972, the largest colony of the species was reduced from more than 1000 animals to less than 50, apparently from poisoning (Enoch, Iron County). The total population declined from approximately 8800 animals in 1970 to 5700 in 1971, a 36% decline in one year (Collier and Spillett, 1972). Three of the five remaining localities where the species occurs in some numbers, are controlled by private individuals. *C. parvidens* was classified as an endangered species in 1968 but was dropped from the list in 1970. It was subsequently relisted as endangered because of substantial decline in numbers from 1970 to 1972 (U. S. Bureau of Sport Fisheries and Wildlife, 1973).

GENETICS. Pizziment and Nadler (1972) examined the chromosomes of *C. parvidens* from five scattered localities, and found a diploid number of 50. The autosomes are four pairs of metacentrics, a graded series of 18 submetacentric to subtelocentric pairs, and two pairs of acrocentric chromosomes; the sex chromosomes are a large submetacentric X and a small acrocentric Y. Interpretation of the sex chromosomes has been somewhat equivocal (Pizzimenti and Nadler, *op. cit.*), but is now confirmed.

REMARKS. It has been suggested that *C. parvidens*, *C. leucurus*, and *C. gunnisoni* are conspecific (Burt and Grossenheider, 1964), and that the nominal groups may represent a polytypic species. Kelson (1949) judged *C. parvidens* to be conspecific with *C. leucurus*, but did not demonstrate any evidence of intergradation. Work is in progress regarding the integrity of these species; (JJP) evidence now at hand suggests that the above-mentioned synonymizing probably is not now supportable. Most authorities do agree, however, that *C. parvidens* and *C. leucurus* are more closely related to each other than to other members of the genus.

ETYMOLOGY. The name *Cynomys* comes from the Greek words *kynos*, meaning dog, and *myos*, meaning mouse. The name *parvidens* is derived from Latin words *parvus*, and *dens*, "small teeth." The name *parvidens* is somewhat of a misnomer in that the teeth are not distinctively smaller than in other members of the genus relative to the size of the skull.

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Cynomys ludovicianus ludovicianus (Ord)

Black-tailed Prairie Dog

Arctomys ludoviciana Ord, 1815, *in* Guthrie, A new geogr., hist., coml. grammar . . ., Philadelphia, Amer. ed. 2, 2:292, description on page 302 (type locality restricted to the "Tower," sec. 10, T. 34 N, R. 10 W, Boyd Co., Nebraska, by Jones, Univ. Kansas Publ., Mus. Nat. Hist., 16:140, 1 October 1964).

Cynomys ludovicianus—Baird, 1858, Mammals, *in* Repts. Expl. and Surv. . ., 8(1):331, 14 July.

The black-tailed prairie dog is a characteristic inhabitant of the short-grass plains of central United States. F. V. Hayden (1862:145) first noted this species in the Hills region: "The largest one [prairie dog town] I have seen is near the Black Hills, north of the Big Sheyenne river [Cheyenne River]. This village, though sometimes interrupted by high ridges or hills is connected, and covers an area of over fifty square miles." The Shirttail Canyon prairie dog town in the southwest corner of Wind Cave National Park was studied extensively by J. A. King (1955). C. B. Koford (1958) also studied the Shirttail Canyon colony, as well as the prairie dog town in Devils Tower National Monument. These two reports were consulted frequently in preparing the present account. Bailey (1888:440-441) described a prairie dog colony that occupied about 40 acres at a place 2 mi E Rapid City.

The Devils Tower prairie dog town comprises about 40 acres between the Belle Fourche River and the pine-clad hills of the National Monument. The town is at least 75 years old; in June 1894, Vernon Bailey noted "a good sized dog town occupies a level section in the valley at base of tower" (USBS files). Counts made in 1947 and 1955 indicated that the population was fairly stable at about 750 prairie dogs. In the area where *Cynomys* are fed by tourists, the number of burrows reaches a maximum density of 100 per acre.

The Shirttail Canyon prairie dog town occupies about 75 acres, covering part of the canyon floor and adjacent terraces. In 1950, King counted 614 burrows on an 11.7 acre sample plot of this town (52.5 per acre). Wind Cave National Park supports seven naturally established prairie dog towns and three new ones that were initiated in the northwesternmost corner of the Park in 1965. *Cynomys ludovicianus* occupies about 655 acres, or three percent of the nonforested portion (21,449 acres) of the Park. Total acreage inhabited by prairie dogs increased by 90 acres from 1963 to 1967.

This species is active the year around, although activity decreases somewhat during the colder months and on cloudy days. Both King and Koford found that males lose more weight than females during winter, possibly indicating that males are more active at that time. Burrows are constructed on floors of canyons and on adjacent terraces, where fine-textured chernozems and chestnut soils enable prairie dogs to excavate deep, continuous passages; at Devils Tower, many burrows were located in fine sand of the Belle Fourche River floodplain. Barriers to expansion of prairie dog towns seem to be unsuitable soils of adjacent slopes, heavy cover, and rough terrain.

Earthen mounds thrown up around the entrances to burrow systems favor establishment of pioneer forbs such as bigbract verbena (*Verbena bracteata*), stickweed (*Lappula redowskii*), dogweed (*Dyssodia papposa*), and false pennyroyal (*Hedeoma hispida*). Koford analyzed the vegetation along a transect through the Shirttail Canyon colony and found that the center of the town supported 67 percent buffalo grass, 24 percent tumblegrass (*Schedonnardus paniculatus*), six percent blue grama, and three percent western wheat grass. In the peripheral area, blue grama and western wheat grass increased in abundance and the town border was dominated by Japanese brome grass (*Bromus japonicus*). Within the confines of a town, prairie dogs usually cut down tall plants that otherwise would obstruct a clear field of observation; examples of such plants are woolly mullein, Russian thistle (*Salsola kali*), snowberry (*Symphoricarpos occidentalis*), silver sagebrush, and brome grass. Other species such as snow-on-the-mountain (*Euphorbia marginata*), clammyweed (*Polanisia graveolens*) and various mustards are left erect, presumably due to a bitter taste, presence of thorns, a tough integument, or other protective devices of the plants. In addition to the numerous plant species listed by King (1955:8 and 9), Koford included scarlet globemallow, cutleaf nightshade (*Solanum triflorum*), pepperweed (*Lepidium densiflorum*) and lamb's-quarters as important foods of *Cynomys ludovicianus* in the Black Hills region.

King reported that the Shirttail Canyon colony was divided into fairly stable social groups of several members, each group occupying a particular territory of approximately one acre in size and each consisting of an adult male with a few females and their young. Even though a mother prairie dog defends the area of her nest burrow, Koford thought it was improbable that this aggressiveness limits the number of families; for example, 11 nest burrows were found in an area of only 1.5 acres in Shirttail Canyon.

Expansion of a dog town presumably occurs when the population density increases shortly after the pups emerge from below ground. King noted that emergence of pups in May raised the average population density from four to 15 prairie dogs per acre. In contrast to the behavior of most rodents, adult prairie dogs move into a new area, from which the young are repulsed. The longest movement recorded by King was 800 feet beyond the edge of the colony. Search for food may be another cause of colony expansion.

In early July 1968, I observed an adult badger and two young excavating a prairie dog burrow in Wind Cave National Park early in the morning. Several burrows in Shirttail Canyon also were dug out by badgers, and coyotes are a fairly common sight in towns early in the morning. Although no actual sightings have occurred since 1953, characteristic trenches of the black-footed ferret were found in the National Park in 1969. King reported that a prairie dog was killed by a golden eagle in the winter of 1955; I observed an eagle swoop down upon an adult prairie dog in the summer of 1968, but the prairie dog escaped into its burrow. Remains of a young *C. ludovicianus* were found in pellets of a great horned owl that was roosting in Wind Cave Canyon in July 1968.

Mating occurs in February and March and two to 10 young are born in early April after a gestation period of 30 to 35 days. The pups emerge from under ground in mid-May. Evidently, only one litter is produced per year. King found no evidence of reproduction among yearlings and noted that mortality was high in the young during the first (36%) and second (22%) years.

King noted that fleas (*Opisocrostis hirsutus*), mites (*Atricholaelaps glasgowi*), and ticks (*Ixodes* sp.) parasitize prairie dogs externally in Shirttail Canyon.

Specimens examined (29).—SOUTH DAKOTA: *Pennington County:* 0.5 mi E Rapid City, 1 (SDSU); Rapid City, 11 (USNM). *Custer County:* McAdam's Ranch, 3 mi NW Wind Cave, 1 (WCNP); Wind Cave National Park, 5 (2 UMMZ, 2 UW); Elk Mountain, 5 (UMMZ); 1 mi NE Wind Cave, Wind Cave National Park, 2 (WCNP).

WYOMING: *Weston County:* Newcastle, 4 (USNM).

Additional records.—SOUTH DAKOTA: *Meade County:* Sturgis (USBS files). *Custer County:* Pringle (USBS files); Horseshoe Bend, 12 mi NE Elk Mountain (USBS files).

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